Application for Resource Consents

To Construct & Operate Te Ruaotehauhau Water Storage Reservoir

TE TAI TOKERAU WATER TRUST

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18 September 2020

Te Ruaotehauhau Water Storage Reservoir

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Glossary of Terms

Term / Abbreviation	Definition
CEMP	Construction Environmental Management Plan
DoC	Department of Conservation
ESCP	Erosion and Sediment Control Plan
FNDC	Far North District Council
FNDP	Far North District Plan
NES-CS	Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011
NES-FW	Resource Management (National Environmental Standards for Freshwater) Regulations 2020
NPS-FM	National Policy Statement for Freshwater Management 2020
NRC	Northland Regional Council
NWSUP	Northland Water Storage and Use Project
PRP	Proposed Regional Plan for Northland (Appeals Version – June 2020)
RAQP	Regional Air Quality Plan for Northland 2005
RMA	Resource Management Act 1991
RPS	Regional Policy Statement for Northland 2016
RWSP	Regional Water & Soil Plan for Northland 2004 (updated 2016)

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1. Introduction

1.1 Overview of the Proposal

Williamson Water & Land Advisory Ltd (WWLA) was commissioned by Te Tai Tokerau Water Trust (the applicant) to prepare this application for resource consents to authorise the construction and operation of the Te Ruaotehauhau Water Storage Reservoir[1], to be located between Hariru Road and Remuera Settlement Road, Kaikohe, in the headwaters of Te Ruaotehauhau Stream and Waitaia Stream (**Figure 1**).

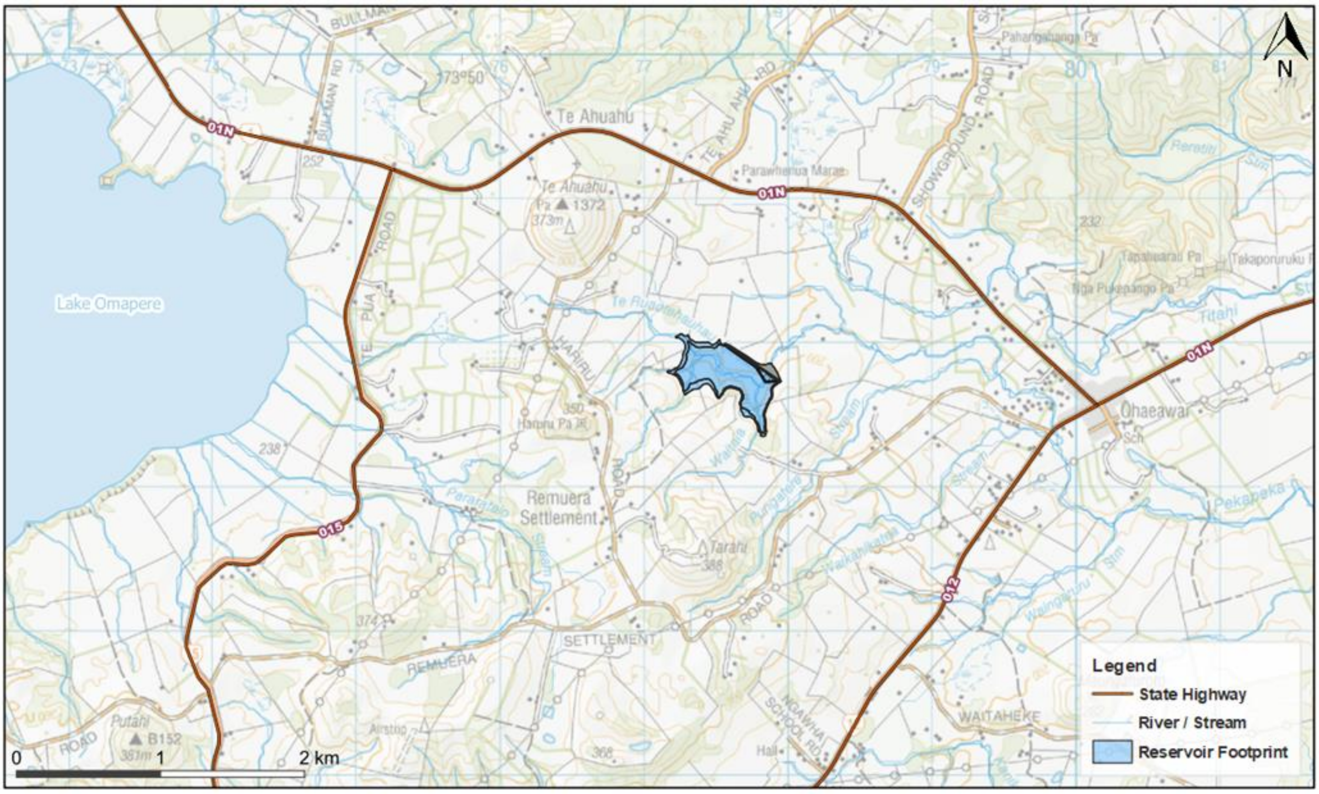

Figure 1: Location of Te Ruaotehauhau Water Storage Reservoir

The proposed reservoir embankment is approximately 21 m high and will be capable of storing 1.4 million cubic metres of water at full supply level. While the exact land the reservoir will service is not currently known (that depends on future uptake), it is expected it will provide sufficient water to irrigate approximately 390 hectares of horticultural development.

The proposed reservoir will be filled by damming direct catchment inflows. High flows above the median flow, up to two times the standard deviation of flow at all times they are available (and when the reservoir is not full), will be dammed, and low flow 'core allocation' outside of the irrigation season (i.e., winter months) will also be dammed. A base flow (i.e., minimum flow) will be maintained through the embankment.

The proposed Te Ruaotehauhau Water Storage Reservoir was identified as a viable water storage option through the Northland Water Storage and Use Project (NWSUP), as a complementary part of a distributed community scheme (refer **Section 2**).

This application is made in accordance with Schedule 4 of the RMA. Resource consents are required under the Resource Management (National Environmental Standards for Freshwater) Regulations 2020 (NES-FW), the

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[1] Also referred to as MN06 in other documents.

Regional Water and Soil Plan for Northland (RWSP), the Proposed Regional Plan for Northland (PRP), and the Far North District Plan (FNDP).

Northland Regional Council's (NRC) and Far North District Council's (FNDC) prescribed application forms for resource consent are attached at **Appendix A**.

1.2 Applicant Details

The applicant's details are set out in **Table 1** below.

Table 1. Applicant details

Charitable Trust Board Name	Te Tai Tokerau Water Trust
NZBN	9429048360210
Incorporation Number	50038862
Charitable Trust Board Status	Registered
Date of Incorporation	16 June 2020
Registered Office Address	Thomson Wilson, 125 Bank Street, Whangarei, 0110, New Zealand

1.3 Report Structure

This report contains the following information:

- An overview of the Northland Water and Storage Use Project (**Section 2**).
- A description of the proposal (**Section 3**).
- A description of the receiving environment (**Section 4**).
- Permitted activities and resource consent requirements (**Section 5**).
- An assessment of the proposal against Part 2 of the RMA and relevant planning provisions (**Section 6**).
- An assessment of the proposal's effects on the environment (**Section 7**).
- A summary of consultation and feedback on the proposal (**Section 8**).
- A description of the how the effects of the proposal will be monitored (**Section 9**).

2. Project Overview and Purpose

Starting in 2013, NRC began investigating opportunities to provide economic benefits in Northland through land use change involving water storage. The work, originally funded by Crown Irrigation Investments Limited, identified two areas that would benefit most from investment: Dargaville area in the Kaipara District and the Mid-North area in the Far North District.

In July 2019, the Ministry of Business Innovation and Employment (MBIE) entered into an agreement with NRC to co-fund the delivery of a prefeasibility phase, including research reports on the technical feasibility and benefits of building water storage reservoirs, harvesting water during high flows, and distributing stored water to stimulate the conversion of existing land use to higher value horticulture activities in the Mid-North and Kaipara. The project was named the Northland Water Storage and Use Project (NWSUP).

The prefeasibility phase was governed by a Project Steering Group (consisting of the chief executive officers of NRC, Far North District Council and KDC and two Crown appointed representatives) and a Project Advisory Group (made up of invited representatives from iwi and hapū, Lake Ōmāpere Trust, landowners, primary industry sectors, environmental agencies and community).

The prefeasibility reports, completed in March 2020, identified that a Mid-North Water Scheme and a Kaipara Water Scheme could provide $150 million per annum lift in GDP and an additional 877 jobs. The Mid-North Water Scheme alone could increase the area’s GDP by 22% and employment by 12%. The overall conclusion of the prefeasibility phases was that a viable scheme exists in the Mid-North and Kaipara areas. The preferred options will consist of multiple water storage sites connected through a distribution system rather than one or two large reservoirs.

The NWSUP is now being delivered by Te Tai Tokerau Water Trust. The proposed Te Ruaotehauhau Water Storage Reservoir is one of four proposed reservoirs in the Mid-North Scheme: Matawii (MN10), MN16, and MN02. The proposed Matawii Water Storage Reservoir (listed project 16 in Schedule 2 of the Act), was the first component of the NWSUP for which resource consents have been sought.

Te Tai Tokerau Water Trust commissioned WWLA, Riley Consultants Ltd (RILEY) and other partners to undertake the NWSUP feasibility demand assessment and design phase. The work is supported by the Provincial Growth Fund and includes obtaining resource consents to authorise the construction and operation of the Mid-North and Kaipara Schemes.

Figure 2 shows the location of the locality of the Mid-North command area.

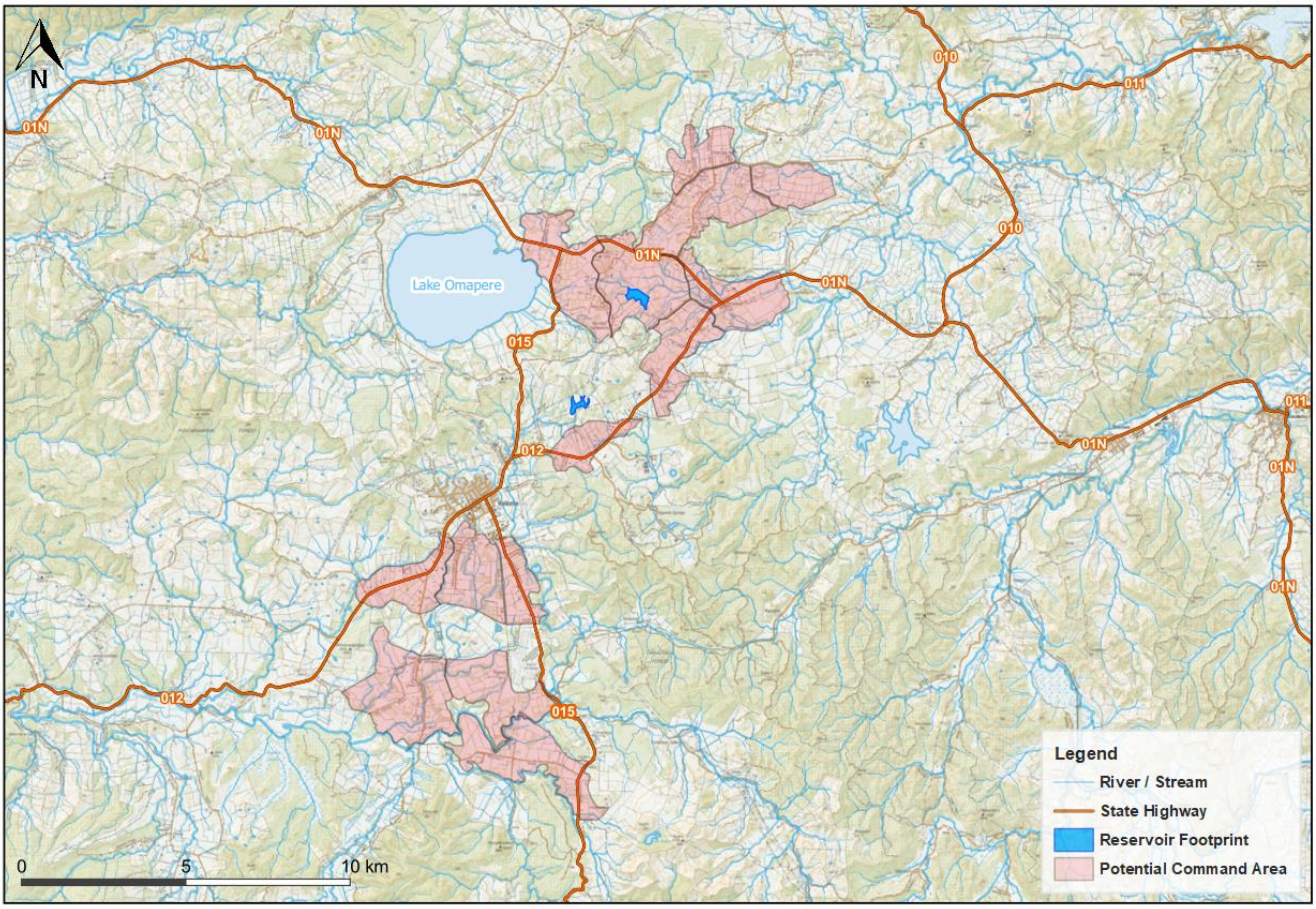

Figure 2. Potential Mid-North command area

2.1 Demand

The Far North district is one of the most economically deprived parts of New Zealand. In 2018, Kaikohe was ranked as the most disadvantaged area in the Far North. Yet the land around Kaikohe includes some of the country's best horticultural soils.

A detailed analysis of soil types, land gradient and solar aspect was undertaken.[2] Around half the land in the Mid-North (54%) command area has been identified as being highly suitable for horticulture production (**Table 2**).

Landowners in the Mid-North command area have expressed strong support for a scheme. The wider primary sector has strong interest in the project and believe that there is significant potential to grow high value horticulture if more water is available, including kiwifruit, avocado, citrus, blueberries and market garden vegetables.

Table 2. Summary of potential demand factors[3]

Variable	Mid-North
Command area (ha)	6,016
Maori Freehold Land (% command area)	17%

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[2] WWLA, 27 March 2020. Volume 1: Command Area Analysis and Refinement – Northland Water Storage and Use Project. Prepared by Williamson Water & Land Advisory Ltd. Project no; WWLA0156.

[3] WWLA, 27 March 2020. Volume 1: Command Area Analysis and Refinement – Northland Water Storage and Use Project. Prepared by Williamson Water & Land Advisory Ltd. Project no; WWLA0156.

Variable	Mid-North
Irrigation area – Farm (ha)	2,700
Irrigation area – Canopy (ha)	1,900
Land in command area identified as very suitable for horticulture (ha)	3,220
Land in command area identified as very suitable for horticulture (%)	54%
Peak Daily Irrigation Water Requirement	76,231 m^3
Annual Irrigation Water Requirement	7.6 Mm^3

2.2 Economic Opportunities

There are significant on-going economic opportunities to be realised through development of the Mid-North Water Scheme (**Table 3**). These benefits arise from both a major increase in horticultural production and flow-on effects to other sectors. Economic analysis in the prefeasibility phase indicates an increase in GDP of $67 million per annum equivalent to a 2.4% increase in the district's current GDP (valued at $2451 million in the year ended March 2019). The projected additional 440 FTE jobs represent a 1.5% increase over pre-COVID-19 employment levels in the district.

Table 3. Potential annual economic impacts of the proposed Mid-North Water Scheme[4]

Variable (per annum)	Direct	Total
Value of output	$143M	$178M
GDP	$52M	$67
Employment (FTE)	350	440
Household Income	22M	$29M

The economic impact of constructing the proposed Te Ruaotehauhau Water Storage Reservoir, a component of the Mid-North Scheme is provided in **Section 6**.

2.3 Community

The Mid-North Water Scheme will supply FNDC with water for the Kaikohe municipal water network. However, it is expected that the water will come from the Matawii Water Storage Reservoir. Discussions between the applicant and FNDC are underway to determine how its municipal water supply systems will need to be reconfigured to accept additional water and how to fund the work through its Long-Term Plan.

2.4 Environment

The use of water to convert land used for pastoral farming to horticulture is likely to benefit the environment through improved water quality due to less sediment and bacterial run-off. **Table 4** summarises the nature of the current land use in the Mid-North command area, which is currently dominated by high producing grassland. The identified water storage sites are predominantly in modified catchments. There is an opportunity to create improved habitat for native flora and fauna as part of creating the proposed reservoir.

Table 4. Current land cover of the command area

Selected land cover type	Mid-North (% command area)
High producing exotic grassland	83%
Short rotation crop land	2%
Indigenous forest or scrub	8%

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[4] Darryl Jones, Economist, Northland Regional Council, March 2020.

Exotic forest	2%
Orchard, vineyard or other perennial crop	1%

2.5 Climate change

It is expected that frequency and severity of droughts will increase with climate change.[5] Having a reliable water supply will become increasingly important to provide resilience for farmers, municipal water supplies, and to support small rural economies. The NWSUP project provides significant opportunities in this regard.

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[5] NIWA, September 2016. Climate Change Projections and Implications for Northland. Prepared for Northland Regional Council. NIWA Client Report No: 2016072AK.

3. Description of the Proposal

3.1 Overview

The applicant is seeking land use consents, pursuant to regulations in the NES-FW, rules in the RWSP, PRP, and the FNDP, and water permits and discharge permits pursuant to regulations in the NEW-FW and rules in the RWSP and PRP to authorise activities associated with constructing and operating the proposed Te Ruaotehauhau Water Storage Reservoir.

The proposed reservoir embankment will be located at the confluence of Te Ruaotehauhau and Waitaia streams, approximately 2.5 km upstream of Okaewai, Northland.

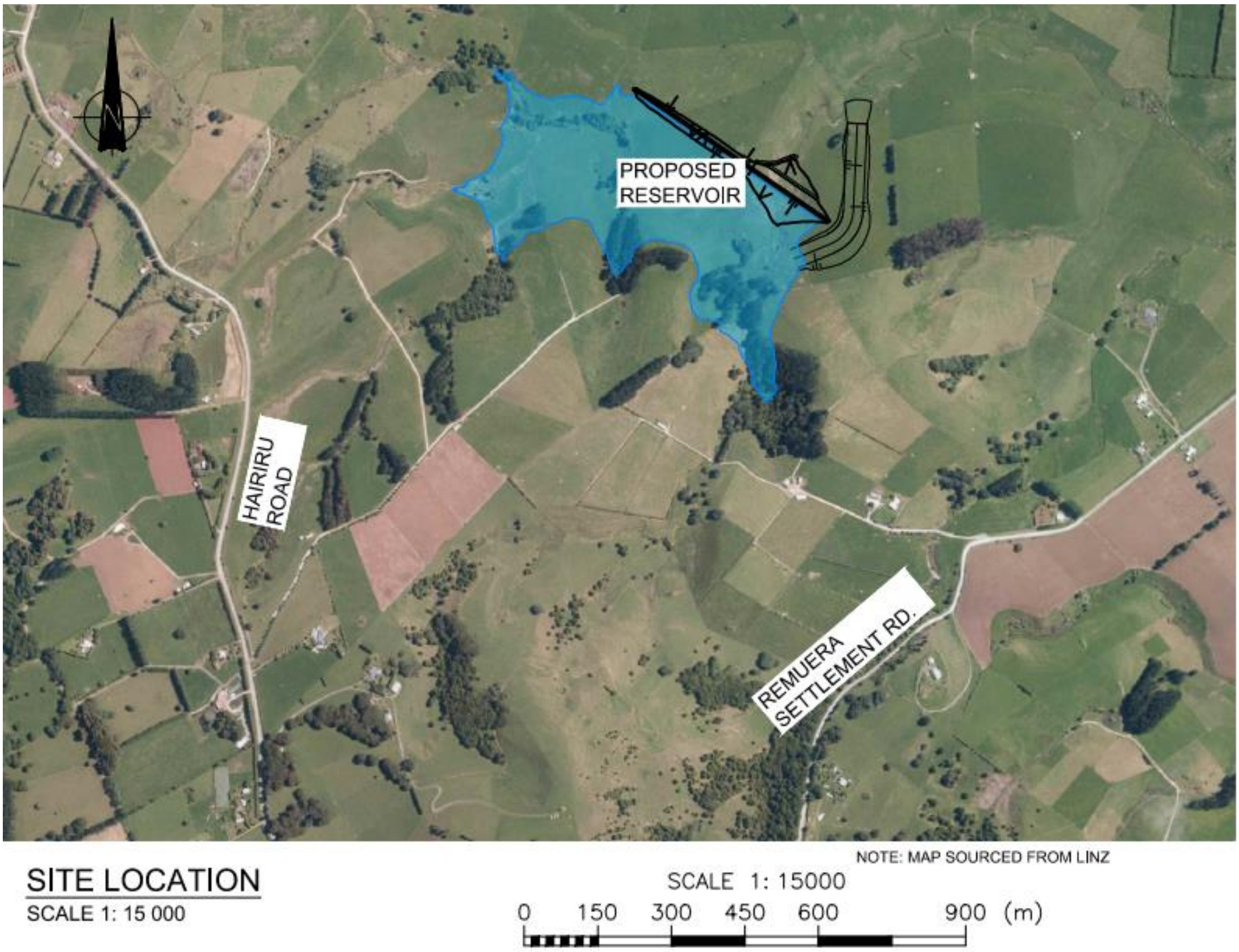

Figure 3. Location of Te Ruaotehauhau Water Storage Reservoir

The proposed reservoir will have a maximum working storage volume of approximately 1.4 million cubic metres. While the exact land the reservoir will service has not been confirmed (that depends on future uptake), it is expected that it will be able to provide sufficient water to irrigate approximately 390 hectares of horticultural development in the Mid-North command area.

The proposed reservoir will be filled through upstream catchment inflows. Specifically, it is proposed that the reservoir embankment will divert and dam:

- High flows above the median flow, up to two times the standard deviation of flows at all times they are available (and the reservoir not full); and

- Low flow 'core' allocation outside of the irrigation season (i.e., winter months) only.

Please see the hydrology assessment report at **Appendix C** for more information.

3.2 Site Details

Records of Title of the land parcels affected by the proposed Te Ruaotehauhau Water Storage Reservoir are contained in **Appendix B** and are summarised in **Table 5**. Information on owners of land adjoining the properties on which the proposed reservoir will be situated is provided in **Table 6**.

A map of the proposed reservoir in relation to the properties is also contained in **Appendix B**.

Table 5: Property and ownership details of the Te Ruaotehauhau Water Storage Reservoir site.

Legal Description	Record of Title	Estate Type	Registered Owner
Lot 2 Deposited Plan 442506	552150	Fee Simple	D.G. Dixon & Son Limited
Lot 5 Deposited Plan 533953	878815	Fee Simple	Bruce Campbell Bell Helen Sheila Bell
Section 16S Remuera Settlement	NA1034/210	Fee Simple	Bruce Campbell Bell Helen Sheila Bell
Lot 3 Deposited Plan 97908	NA53B/976	Fee Simple	Mountain View Farms 2018 Limited
Okokako	NA768/20	Fee Simple	D.G. Dixon & Son Limited

Table 6. Property and ownership details of land adjacent to the Te Ruaotehauhau Water Storage Reservoir

Legal Description	Record of Title	Estate Type	Registered Owner
Section 23S Remuera Settlement	NA85A/645	Fee Simple	Lorraine Margaret Lewis
Lot 1 Deposited Plan 97908	NA53B/974	Fee Simple	Mountain View Farms 2018 Limited
Lot 2 Deposited Plan 97908	NA53B/975	Fee Simple	Mountain View Farms 2018 Limited
Pt Hariru B & Poukai A	NA15B/55	Fee Simple	Patricia Mary Seymour Sheila Claire Hay-MacKenzie Stephen Matenga McManus
Pirikotaha 9B2A	355629	Fee Simple	The Maori Trustee
Pirikotaha 9B2B	417851	Fee Simple	Multiple owners
Pirikotaha 9B2C2	355517	Fee Simple	Multiple owners
Lot 2A Deposited Plan 4440	NA98D/903	Fee Simple	D G Dixon & Son Limited
Lot 1 Deposited Plan 177644	NA108D/107	Fee Simple	Northcorp Limited
Lot 1 Deposited Plan 192070	NA121C/8	Fee Simple	Gary Edward Williams Sylvia Iris Williams Bavage Chapman Trustees Limited

3.3 Geotechnical Conditions

A geotechnical and site suitability assessment for the proposed reservoir was completed by RILEY (refer **Appendix D**). At the time of writing this application, RILEY was undertaking comprehensive ground investigations, of which to date the findings are consistent with those of the preliminary geotechnical assessment. The investigations are necessary for detailed design.

3.4 Reservoir Construction

It is intended for construction to commence in March 2021 and it is expected that the reservoir will be constructed by the end of the 2021/2022 earthworks season. This section provides summary details from RILEY's geotechnical and site suitability assessment report.

The reservoir embankment will be approximately 21m high in the main valley section and around 400m long. Only the central portion of the embankment (approximately 50m in length) will be 10m to 20m high. The majority of the embankment, which extends approximately 300m to the northwest, is generally less than 5m to 10m high.

The embankment will have up- and down-stream slope batters of 1V:3H (horizontal : vertical) and 1V:2H with a 5m wide mid-height bench, and 5m wide crest. There is potential for the down-stream slope batter of the left-hand embankment to be 'eased' to a gentler slope so that its integrates more effectively with the contextual topography.

A low-level conduit installed within the valley floor at the toe of the left abutment will provide temporary flood diversion during construction, and house both a residual flow pipe and supply pipes. A flood spillway is envisaged to be formed beyond the right abutment, discharging to the stream approximately 200m below the dam.

The embankment will comprise a riprap facing on the upstream side of the 3H:1V embankment slope to prevent erosion of the dam face, and the downstream dam face will be maintained in grass. No material is intended to be exported from the site, and only a small amount of specialist filter aggregate and riprap will be imported for the dam embankment and reservoir formation.

It is expected that approximately 306,140m^3 of earthworks will be required to construct the proposed reservoir (see **Table 7** below).

Table 7. Estimated volumes of earth to be cut and filled associated with constructing the proposal reservoir.

Activity	**Estimated volume of earth (m^3)**
Fill for dam embankment	143,270
Excavation of unsuitable in dam foundation	19,600
Excavation for auxiliary spillway	92,610
Balance of excavation from borrow area	50,660
Total	**306,140**

The anticipated site management and processes that will be utilised during construction have yet to be finalised and will be subject to review and updates once the design is complete and a contractor appointed. The applicant proposes that a Construction Environmental Management Plan be developed and implemented in accordance with a condition of resource consent. The key purposes of the CEMP will be:

- To ensure compliance with resource consent conditions and other relevant RMA requirements;
- Provide specific guidance on the management of construction and commissioning activities; and
- To ensure any adverse effects associated with the construction and commissioning of the proposed reservoir are appropriate remedied or mitigated.

Erosion and sediment control measures will be undertaken throughout the duration of the construction phases in accordance with industry best practice (i.e., Auckland Council Guideline Document 2016/005[6]). The purpose

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[6] Auckland Council (2018). Erosion and sediment control guide for land disturbing activities in the Auckland region. Auckland Council Guideline Document GD2016/005. Incorporating amendment 1. Prepared by Beca Ltd and SouthernSkies Environmental for Auckland Council.

of the erosion and sediment control measures is to minimise, to the full extent practicable, erosion, sediment discharges and sedimentation occurring during and after the construction of the proposed reservoir.

It is proposed that a condition of the sought resource consent requires a comprehensive Erosion and Sediment Control Management Plan (ESCMP) to be prepared and submitted to NRC and FNDC for approval prior to any earthworks commencing (refer **Appendix J**). The ESCMP will be prepared in accordance with Auckland Council Guideline Document 2016/005 and will be part of the CEMP.

Disestablishment works will include ensuring stabilisation of all earthworks, and retention and management of erosion and sediment control devices for a minimum 3-month period or until vegetation has established.

All construction related infrastructure including the temporary site premise will be deconstructed on completion. A sealed (gravel) access will be maintained to the dam site post construction.

3.5 Reservoir Operation Activities

The reservoir will be operated in accordance with an Operational Reservoir Management Plan (ORMP), which is to be prepared as a proposed requirement of a condition of consent (refer **Appendix J**). Operation and monitoring of the system will be in accordance with the ORMP that will be developed from the principles outlined in the NZSOLD Dam Safety Guidelines. The ORMP is expected to include the following details:

- An overview of the reservoir characteristics, construction, and as-built details.
- Relevant as-built drawings will be including particularly those relating to its operation and maintenance.
- Roles and responsibilities of the various parties.
- Inspection forms for engineering, water monitoring and maintenance inspections.
- Operational/design storage levels and conditions for spillways
- Design levels, triggers and telemetric monitoring requirements.
- Data management and information ownership.
- Maintenance functions and reporting requirements.
- Details of annual reporting requirements to NRC and FNDC.

Filling of the reservoir will commence with re-connection of diverted Te Ruaotehauhau Creek with all flows retained behind the embankment, while residual flow is proposed to be passed via a conduit pipe discharging through the dam embankment (refer **Appendix E**).

While the reservoir is filling, the residual flow cannot be provided for by the conduit pipe due to the cover level of this pipe and water levels. The preferred option for residual flow provision during filling has not been decided at this time but could include maintaining the construction diversion channel with a high flow offtake channel until the reservoir water level is sufficient to cover the conduit pipe. The final detail on the residual flow bypass will be confirmed in the ORMP. A condition requiring the provision of a continuous residual flow is proposed. The filling process will take some time, the timing dependant on the season in which reconnection of the stream occurs. Filling will be monitored according to the ORMP.

Table 8 sets out the proposed rates of take from the reservoir.

Table 8. Proposed rates of take from the reservoir to support 390 ha of horticulture development

Take	Rate
Median Annual Take	776,000 m^3/yr
1:10 Year ARI Take	1,470,000 m^3/yr
Maximum Daily Take	190 L/s

4. Description of the Receiving Environment

4.1 General Settings

The site of the proposed reservoir is located within properties identified in **Section** of this application and is located approximately 2km to the west of Ohaewai, near Kaikohe. The topography falls generally to the south east. Pastoral farming is the primary land use at and around the site, although there are pockets of horticulture land use to the east and west. The majority of the properties in the vicinity of the site are relatively large.

Figure 4. The downstream north-east view from the reservoir.

4.2 Zoning

The site of the proposed reservoir is in the Rural Production Zone (FNP). Chapter 8.6 of the FNP describes the zone as “predominantly a working productive zone”, which:

> *… contains environmental and amenity standards which will enable the continuation of the wide range of existing and future activities, compatible with normal farming and forestry activities, and with rural lifestyle and residential uses, while ensuring that the natural and physical resources of the rural area are managed sustainably. Activities that are ancillary to farming or forestry may also have a functional need to be within the rural environment, however, such rural processing and servicing activities may be less compatible in more intensively settled locations. The standards in the Rural Production Zone are also aimed at enabling farming and activities ancillary to rural production whilst maintaining and enhancing amenity values associated with the rural environment, and at minimising the likelihood and risk of incompatible land uses establishing in proximity to each other.*

There are no planning overlays in the FNP that affect the site.

The Te Ruaotehauhau Stream is classified as a “small river” in the PRP for the purposes of setting freshwater quantity objectives and associated minimum flows and allocation limits.

4.3 Terrestrial Environments

4.3.1 Landform and geology

An assessment of landscape and visual amenity effects of the proposed Te Ruaotehauhau Water Storage Reservoir was prepared by Simon Cocker Landscape Architecture. The report, attached at **Appendix G**, contains detailed information on the topography, geology and soils of the site and its context.

The report on the assessment of landscape and visual amenity effects describes the landscape of the area as being characterised by its volcanic origins, with volcanic cones being focal features. Weathering of the volcanic basalt scoria cones and basalt flows has produced rich volcanic soils in the Mid-North area.

RILEY's geotechnical and site suitability assessment report states that the embankment of the proposed reservoir will be located on a volcanic plateau, with a topography of a generally flat terrace to the lest abutment and moderate slops on the right, each formed by the pre-historic lava flows.

Figure 5 shows the location of the proposed embankment. Te Ahuahu scoria cone is partly obscured by fog in the middle background.

Figure 5. View west from the right embankment along the main dam alignment. [Reproduced from Figure 1 of Monk-Fromont (2020].

4.3.2 Terrestrial Ecology

An assessment of ecological effects of the proposed reservoir site was undertaken by Puhoi Stour Ltd in associated with Tonkin & Taylor Ltd, and is attached at **Appendix F**.

The report on the assessment of ecological effects points out that there are no mapped significant ecological areas at the sites, although the site is close to several protected natural areas which are comprised of volcanic broadleaf forest, pūriri forest, and habitat for native fauna such as kauri snail, North Island brown kiwi, kukupa, spotless crake, banded rail, and bittern. The pre-human vegetation cover of the site and the wider area would have consisted of pūriri and taraire forest.

The report states that the "footprint [of the proposed reservoir] primarily consists of farm paddocks with pasture grass and exotic forest (pine, wattle, eucalyptus and redwood), as well as isolated patches of indigenous forest and wetland along stream margins and at the edges of the proposed reservoir". The following indigenous terrestrial habitat types were identified:

- 0.47 ha of pūriri forest on basalt volcanic substrate – considered to be of very high ecological value.
- 0.32 ha of riparian swamp forest – considered be of very high ecological value.
- 0.44 ha of secondary broadleaf forest with old-growth remnants – considered to be of very high ecological value.
- 0.14 ha of tōtara treeland – considered to be of moderate ecological value.
- 0.75 ha of volcanic boulderfield – considered to be of high ecological value.
- 0.03 ha of rautahi wetland – considered to be of high ecological value.
- 0.05 ha of kutakuta wetland (artificial pond).

In regard to Threatened or At Risk plan species, the ecological assessment report documents kānuka (*Kunzea robusta*) and rātā vines (*Metrosideros perforate* and *M. diffusa*) which are classified as Threatened – Nationally Vulnerable due to the potential threat of myrtle rust. Similarly, manuka (*Leptospermum scoparium*) is present in low abundance and is classified as At Risk – Declining due to the threat of myrtle rust. Five swamp maire (*Syzium maire)*, which are classified as Threatened – Nationally Critical, were identified in the proposed reservoir footprint.

It is also important to note that the site is likely to provide habitat for native avifuana, herpetofauna, and invertebrates ranging from low to very high ecological value.

4.3.3 Cultural Landscape & Features

WWLA commissioned Geometria Ltd to undertake an archaeological assessment, on behalf of the applicant, of the proposed Te Ruaotehauhau Water Storage Reservoir. The assessment (at **Appendix H**) provides a detailed overview of the pre- and post-colonial history of the site and the broader area within which it is located. In short, Geometria states that the "wider landscape [within which the site is located] is highly archaeologically, historically and culturally significant."

Regarding archaeological features, the report on the archaeological assessment of effects states:

> *The proposed new reservoir will affect an archaeological landscape, comprising approximately 10ha of proto and or pre-historic Maori horticultural features. Artefacts, cultivable taro, obsidian artefacts, and historic stone walls are found in association with the horticultural system which comprises low stone mounds and shallow trenches. These features were previously unrecorded and have now been added to the New Zealand Archaeological Association database ArchSite as P05/1091.*
>
> *While not locally or regionally rare, these features are in good condition and are associated with a highly significant historic and cultural landscape. The site has been assessed as being of moderate archaeological significance overall.*

The Resource Management Unit of Taiāmai ki te Takutai Moana is preparing a cultural impact assessment on behalf of Ngā Hapū, with close oversight by Matua McManus, and that they will include evidence from Te-Rūnanga-ā-Iwi-o-Ngāpuhi that the cultural impact assessment is also prepared on behalf of the Iwi Authority as is required under the Act. Taiāmai ki te Takutai Moana is a charitable trust that represents all the hapū of Taiāmai ki te Marangai that tātai to the whenua for the purposes of the RMA.

The impact assessment was not completed at the time this application was lodged. However, it is understood that the assessment be available to the consent authority prior to it making a decision on whether to grant resource consents..

4.3.4 Contaminated land

WWLA undertook a preliminary contaminated land assessment of the site following a desktop review of historical aerial imagery sourced from Google Earth and Retrolens. WWLA findings are set out in a memorandum attached at Error! Reference source not found.. In summary, no contaminated land-related issues have been identified relating to the reservoir footprint or outside of the reservoir footprint, and therefore no contaminated land related mitigation or management is required.

4.4 Aquatic Environments

4.4.1 Te Ruaotehauhau Stream and Ecological Values

Te Ruaotehauhau Stream and Waitaia Stream flow through the footprint of the reservoir. The report on the assessment of ecological effects (refer **Appendix F**) describe the streams as continually flowing hard bottom streams, having natural channels, and are either shaded under remnant native vegetation and exotic treelands or are open channels along paddock margins. Several permanent tributaries of the streams flow through the site. However, several of the upper reaches of tributaries of Te Ruaotehauhau Stream are intermittent due to shallow water depth and the likelihood of them drying out during summer. The bank-full width of Te Ruaotehauhau Stream is, on average, 2.5m and its approximate depth is 0.5m. The bank-full width of Waitaia Stream is, on average, 1.5m and with an approximate depth of 0.4m.

During ecological investigations, valuations for representative stream reaches across the site based on a combination of stream characteristics, macroinvertebrate communities, and fish communities were considered. They consider that the stream ecological values for both intermittent and continuously flowing streams to be between high and very high.

Three longfin eels (*Anguilla dieffenbachia*) were noted in the streams flowing through the site. The longfin eel is classified as an At Risk – Declining species. The ecological report states that the presence of longfin eel at the site meets the ‘rarity/distinctiveness’ criteria within Appendix 5 of the Regional Policy Statement for Northland (RPS), and therefore the stream channels are classified under the RPS as ‘signficant habitats for indigenous fauna’.

4.4.1.1 Hydrology

WWLA undertook catchment modelling to characterise the existing hydrological regime of the Te Ruaotehauhau Stream Catchment (refer **Appendix C**). **Table 9** below sets out key flow statistics at the embankment of the proposed reservoir. The simulated streamflow reflect are typical: high flow events occur in response to rainfall events, while stream baseflow exhibits a seasonal pattern, with higher baseflow occurring during winter, and low flows during summer.

Table 9. Flow statistics at the embankment of the proposed Te Ruaotehauhau Water Storage Reservoir

Statistic	Value
Minimum (L/s)	2.1
Median (L/s)	28.9
Maximum (L/s)	3,188
7-Day MALF (L/s)	7.5
FRE3 (count)	22

4.4.1.2 Recreational and Amenity Values

While Te Ruatehauhau Stream and Waitaia Stream are highly valued from cultural and ecological perspectives, it is understood that they are not used for contact recreation. The nearest known downstream popular river swimming sites are in the lower reaches of the Waitangi River.[7] The proposed reservoir is very unlikely to have any adverse effects on recreational or amenity values. This is demonstrated by the assessment of hydrological effects on downstream reaches (refer **Appendix C**).

4.4.1.3 Consumptive Take Values

It is understood that there are two consented surface water takes downstream of the proposed reservoir (AUT.071199.01.02 and AUT.028688.01.02). The purpose of the consents is listed as “to take water for pasture irrigation”. There are no other downstream consented surface water takes until the lower reaches of the Waitangi River. It is expected that there are downstream takes authorised by section 14(3)(b) of the RMA and permitted by regional rules.

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[7] Booth, et al. December 2013. River Swimming in Northland: Application of the River Values Assessment System (RiVAS and RiVASS+). Land Environment and People Research Paper No. 22. Lincoln University, Canterbury, New Zealand.

5. Permitted Activities and Resource Consent Requirements

This section identifies regulations and rules that are relevant to the proposal.

5.1 Resource Management Act 1991

The proposal includes land use activities, activities in the bed of a river, taking, using, damming and diverting fresh water, and discharges to land, air and water.

Section 9 of the RMA places restrictions on the use of land:

> *(1) No person may use land in a manner that contravenes a national environmental standard unless the use—*
>
> *(a) is expressly allowed by a resource consent; or*
>
> *(b) is allowed by section 10; or*
>
> *(c) is an activity allowed by section 10A; or*
>
> *(d) is an activity allowed by section 20A.*
>
> *(2) No person may use land in a manner that contravenes a regional rule unless the use—*
>
> *(a) is expressly allowed by a resource consent; or*
>
> *(b) is an activity allowed by section 20A.*
>
> *(3) No person may use land in a manner that contravenes a district rule unless the use—*
>
> *(a) is expressly allowed by a resource consent; or*
>
> *(b) is allowed by section 10; or*
>
> *(c) is an activity allowed by section 10A.*

Section 13 of the RMA places restrictions on certain uses of beds of lakes and rivers:

> *(1) No person may, in relation to the bed of any lake or river,—*
>
> *(a) use, erect, reconstruct, place, alter, extend, remove, or demolish any structure or part of any structure in, on, under, or over the bed; or*
>
> *(b) excavate, drill, tunnel, or otherwise disturb the bed; or*
>
> *(c) introduce or plant any plant or any part of any plant (whether exotic or indigenous) in, on, or under the bed; or*
>
> *(d) deposit any substance in, on, or under the bed; or*
>
> *(e) reclaim or drain the bed—*
>
> *unless expressly allowed by a national environmental standard, a rule in a regional plan as well as a rule in a proposed regional plan for the same region (if there is one), or a resource consent.*
>
> *(2) No person may do an activity described in subsection (2A) in a manner that contravenes a national environmental standard or a regional rule unless the activity—*
>
> *(a) is expressly allowed by a resource consent; or*
>
> *(b) is an activity allowed by section 20A.*
>
> *(2A) The activities are—*
>
> *(a) to enter onto or pass across the bed of a lake or river:*
>
> *(b) to damage, destroy, disturb, or remove a plant or a part of a plant, whether exotic or indigenous, in, on, or under the bed of a lake or river:*
>
> *(c) to damage, destroy, disturb, or remove the habitats of plants or parts of plants, whether exotic or indigenous, in, on, or under the bed of a lake or river:*
>
> *(d) to damage, destroy, disturb, or remove the habitats of animals in, on, or under the bed of a lake or river.*

Section 14 of the RMA places restrictions and duties on the taking, use, damming, diversion of water:

> …
>
> *(2) No person may take, use, dam, or divert any of the following, unless the taking, using, damming, or diverting is allowed by subsection (3):*

> *(a) water other than open coastal water; or ...*
>
> *(3) A person is not prohibited by subsection (2) from taking, using, damming, or diverting any water, heat, or energy if—*
>
> *(a) the taking, using, damming, or diverting is expressly allowed by a national environmental standard, a rule in a regional plan as well as a rule in a proposed regional plan for the same region (if there is one), or a resource consent; or*
>
> *(b) in the case of fresh water, the water, heat, or energy is required to be taken or used for—*
>
> *(i) an individual's reasonable domestic needs; or*
>
> *(ii) the reasonable needs of a person's animals for drinking water,—*
>
> *and the taking or use does not, or is not likely to, have an adverse effect on the environment; or …*
>
> *(e) the water is required to be taken or used for emergency or training purposes in accordance with section 48 of the Fire and Emergency New Zealand Act 2017.*

Section 15 of the RMA places restrictions on discharges:

> *(1) No person may discharge any—*
>
> *(a) contaminant or water into water; or*
>
> *(b) contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating as a result of natural processes from that contaminant) entering water; or …*
>
> *unless the discharge is expressly allowed by a national environmental standard or other regulations, a rule in a regional plan as well as a rule in a proposed regional plan for the same region (if there is one), or a resource consent.*
>
> *(2) No person may discharge a contaminant into the air, or into or onto land, from a place or any other source, whether moveable or not, in a manner that contravenes a national environmental standard unless the discharge—*
>
> *(a) is expressly allowed by other regulations; or*
>
> *(b) is expressly allowed by a resource consent; or*
>
> *(c) is an activity allowed by section 20A.*
>
> *(2A) No person may discharge a contaminant into the air, or into or onto land, from a place or any other source, whether moveable or not, in a manner that contravenes a regional rule unless the discharge—*
>
> *(a) is expressly allowed by a national environmental standard or other regulations; or*
>
> *(b) is expressly allowed by a resource consent; or*
>
> *(c) is an activity allowed by section 20A.*

5.2 National Environmental Standards

Relevant national environmental standards and regulations are:

- Resource Management (National Environmental Standards for Freshwater) Regulations 2020.
- Resource Management (Measurement and Reporting of Water Take) Regulations 2010.
- Resource Management (National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health (NESCS) Regulations 2011.

5.2.1 Resource Management (National Environmental Standards for Freshwater) Regulations 2020

The NES-FW were gazetted on 3 August 2020 and come into force on 3 September 2020. It contains standards for farming activities (Part 2) and standards for other activities that relate to freshwater (Part 3), including activities in and adjacent to natural wetlands, reclamation of rivers, construction of culverts, and information requirements about dams. **Table 10** identifies the regulations that are relevant to the construction of the proposed reservoir.

5.2.2 Resource Management (Measurement and Reporting of Water Takes) Regulations 2010

The Regulations establish a nationally consistent regime for measuring water use. The regulations only apply to a water permit that allows fresh water to be taken at a rate of 5 litres per second or more, and do not apply to a water permit for a non-consumptive take.

Dewatering the reservoir footprint will be required to stabilise the soils prior to reservoir construction. The shallow groundwater will then be discharged back to Te Ruaotehauhau Stream just below the point of take. The exact dewatering design has yet to be completed. However, the taking of shallow groundwater for site dewatering is deemed to be a non-consumptive take, which is defined in the Regulations as (clause 4(2)):

(a) The same amount of water is returned to same water body at or near the location from which it is taken; and

(b) There is no significant delay between the taking and returning of the water.

The application is also made for a water permit to authorise the taking of water from the dam for use. The take rate will exceed 5 L/s and therefore the applicant will be required to measure the water take, store the water take records, and electronically submit the water take data to NRC in accordance with the Regulations.

5.2.3 National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health Regulations 2011

The NESCS came into effect on 1 January 2012. The legislation sets out nationally consistent planning controls appropriate to district and city councils for assessing potential human health effects related to contaminants in soil. The regulation applies to specific activities (including land use change and soil disturbance, activities associated with reservoir development) on land where an activity included on the HAIL has occurred.

The contaminated land investigation (Appendix J) confirms there are no HAIL activities on the land thus the NESCS does not meet the regulations applicability criteria in Regulation 5, Clause 7.

5.3 Regional Plans

The following tables (**Tables 10 – 12**) identifies rules in PRP, RWSP and the Regional Air Quality Plan for Northland (RAQP) for activities associated with the construction and operation of the Te Ruaotehauhau Water Storage Reservoir.

5.4 Far North District Plan

Table 14 contains an assessment of rules in the FNDP that apply to activities associated with the construction of the proposed reservoir.

Table 10. National regulations in the NES-FM relating to the construction of the Te Ruaotehauhau Water Storage Reservoir.

Regulation	Description of the relevant activity/activities or matter covered by the regulation	Assessment of the activity
54 – 'Non-complying activities'	The regulation states that the following activities are non-complying activities if they do not have another statis under subpart 1: (a) vegetation clearance within, or within a 10 m setback from, a natural wetland: (b) earthworks within, or within a 10 m setback, from, a natural wetland: (c) the taking, use, damming, diversion, or discharge of water within, or within a 100 m setback from, a natural wetland. A natural wetland is defined in the NPS-FM 2020 as: *"…a wetland (as defined in t he Act) that is not:* *(a) a wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore, an existing or former natural wetland); or* *(b) a geothermal wetland; or* *(c) any area of improved pasture that, at the commencement date, is dominated by (that is more than 50% of) exotic pasture species and is subject to temporary rain-derived water pooling."*	Construction of the proposed reservoir will involve the removal of woody vegetation within the reservoir footprint and earthworks associated with site preparation. There is small section of grazed rautahi (*Carex geminata*) dominated wetland (approximately 0.03 ha) along the Te Rautehauhau Stream margin. It is likely that vegetation clearance and earthworks will occur within, or within a 10 m setback of, the wetland. Therefore, an application for a resource consent is sought pursuant to regulation 54.
57 – 'Discretionary activities'	The regulation states that the reclamation of the bed of any river is a discretionary activity. The term reclamation is defined in the National Planning Standards 2019 as: *"…the manmade formation of permanent dry land by the positioning of material into or onto any part of a waterbody, bed f a lake or river or the coastal marine area, and:* *(a) includes the construction of any causeway; but* *(b) excludes the construction of natural hazard protection structures such as seawalls, breakwaters or groynes except where the purpose of those structures is to form dry land."*	The construction of the embankment will involve reclamation of Te Ruaotehauhau Stream at the site of reservoir embankment. An application for a resource consent is sought pursuant to regulation 57.
62 – 'Requirements for all activities: information about structures and passage of fish'	The regulation sets out information requirements about structures and passage of fish. The regulation requires information specified in the regulation to be collected and provided to the relevant regional council within 20 working days after the activity is finished, as a condition of resource consent granted for the activity.	The proposed reservoir embankment is a structure.

Regulation	Description of the relevant activity/activities or matter covered by the regulation	Assessment of the activity
		The information required by regulation 62 will be provided to Northland Regional Council in accordance with a condition of resource consent.
63 – 'Requirement for culvert activities: information about culverts'	The regulation sets out information requirements about culverts. The regulation requires information specified in the regulation to be collected and provided to the relevant regional council within 20 working days after the activity is finished, as a condition of resource consent granted for the activity.	The Te Ruaotehauhau Stream needs to be diverted during construction to provide a dry working area during construction and also to prevent the overtopping of a partially formed embankment. The intent is to construct a diversion culvert offline from the existing stream. When the culvert is completed, the stream will be diverted into the culvert, and the upstream shoulder of the dam will be preferentially constructed ahead of the downstream area, to form a cofferdam. Preliminary calculations indicate that a 1500mm to 1800mm dimeter culvert will have sufficient capacity to pass the 50-year flood. Further assessments will be required at detailed design stage, potentially including an analysis of floods with lower likelihood of occurring but with higher downstream consequences. The information will be provided to Northland Regional Council as a condition of resource consent granted for the relevant activities.
66 – 'Requirement for dam activities: information about dams'	The regulation sets out information requirements about dams. The regulation requires information specified in the regulation to be collected and provided to the relevant regional council within 20 working days after the activity is finished, as a condition of resource consent granted for the activity.	The information will be provided to Northland Regional Council in accordance with a condition of resource consent.
68 – 'Requirement for certain structure activities: information about aprons and ramps'	The regulation sets out information requirements about aprons and ramps. The information is required pursuant to regulations 63, 66, and 68.	The information will be provided to Northland Regional Council in accordance with a condition of resource consent.
69 – 'Conditions of resource consent for activities: monitoring and maintenance'	The regulation specifies conditions that must be imposed in resource consent granted for the placement, use, or alteration of the following structures in, on, over, or under the bed of any river or connected area: (a) a culvert (b) a dam	The information will be provided to Northland Regional Council in accordance with a condition of resource consent.
71 – 'Discretionary activities'	The regulation states that the placement, use, alteration, extension, or reconstruction of a culvert in, on, over, or under the bed of a river is a discretionary activity if it does not comply with any of the conditions in regulation 70(2).	It is not clear if the placement and use of a culvert for the purposes of stream diversion during reservoir construction will comply with all conditions of regulation 70(2). Therefore, an application for a resource consent is sought pursuant to regulation 71.

Table 11. Relevant rules in the PRP (Appeals Version, June 2020)

Rule	Description of the relevant activity/activities covered by the rule	Comment
C.2.1.11 'Activities in the beds of lakes and rivers – discretionary activity'	The following activities that are not the subject of any other rule in the plan are discretionary activities: • Disturb the bed of a river. • Deposit a substance in, on, or under the bed of a river. • Reclaim or drain the bed of a river.	Constructing the proposed reservoir will involve disturbing the beds at the site of the proposed embankment. This includes disturbance associated with diverting Te Ruaotehauhau Stream during the construction to provide a dry working area and the installation of a culvert offline form the existing tributaries. There is also the potential for disturbance of other tributaries in the reservoir site and deposition of substances during site preparation.
C.3.1.1 'Off-stream damming and diversion – permitted activity'	The damming or diversion of rainfall runoff, including in sediment ponds and stormwater detention structures, or water in an artificial watercourse, subject to conditions.	It is understood that a cofferdam will be constructed to divert surface water runoff away from the reservoir embankment construction site.
C.3.1.7 'River channel diversion – discretionary activity'	The diversion of water in a river and any associated disturbance of the bed or deposition of material on the bed.	Te Ruaotehauhau Stream need to be diverted during construction.
C.3.1.8 'Damming or diverting water – discretionary activity'	The use, erection, reconstruction, placement, alteration or extension of a dam in the bed of a river, lake or natural wetland, any associated disturbance of the bed of a river or lake and deposition of material on the bed, and the associated damming and diversion of water.	The construction of the proposed reservoir embankment is a discretionary activity.
C.5.1.12 'Other water takes – discretionary activity'	The taking and use of water that is not the subject of any other rule in this Plan is a discretionary activity.	The proposal involves the taking of groundwater for the purposes of ground improvement works. The rate and duration of take exceed the permitted conditions in rule C.5.1.6. The proposal also involves the taking and use of stored water from the reservoir. Because the stored water is from an available allocation the activity is discretionary (not non-complying).
C.6.9.4 'Discharge of water from a reservoir – permitted activity'	The discharge of water from a reservoir into water or onto land where it may enter water.	Water will be discharged (i.e., diverted) from the reservoir via a spillway during rainfall events when the reservoir is at full capacity. It is considered that such discharges will comply with the conditions of rule C.6.9.4. That is, the discharge will not cause:

Rule	Description of the relevant activity/activities covered by the rule	Comment
		• any permanent scouring or erosion of the channel or banks of the receiving water body at the point of discharge, or • any of the following effects in the receiving waters beyond the zone of reasonable mixing: ○ an increase in the temperature of the water by more than three degrees Celsius, or ○ a conspicuous change in the colour or visual clarity, or ○ an emission of objectionable odour, or ○ the rendering of fresh water unsuitable for consumption by farm animals. The spillway will be designed to have a flow risk of erosion (refer **Appendix E**).
C.7.2.7 'Discharges to air – permitted activity'	The discharge of a dust into air from an earthworks activity that is not specifically regulated under a rule in the PRPN there is a permitted activity under Rule C.7.2.7 as it complies with the conditions of the rule.	Discharges of dust to air associated with construction activities will not be from an industrial or trade premises or dry abrasive blasting, and the discharge will not result in any noxious, dangerous, offensive or objectionable odour, smoke, dust, or any noxious or dangerous levels of airborne contaminants beyond the boundary of the subject property.
C.8.3.4 'Earthworks – discretionary activity'	Earthworks outside the bed of a river or wetland, and any associated damming and diversion of stormwater and discharge of stormwater onto or into land where it may enter water, that are not a permitted or controlled activity under another rule in section C.8.3 of the plan.	The earthworks required for constructing the proposed reservoir will exceed permitted and controlled activity thresholds. As such, the earthworks and the associated damming and diversion of stormwater and discharge of stormwater are discretionary activities.
C.8.4.3 'Vegetation clearance in riparian areas – discretionary activity'	Vegetation clearance within 10 metres of a natural wetland, or within 10 metres of the bed of a continually or intermittently flowing river, and any associated damming and diversion of stormwater and discharge of stormwater onto or into land where it may enter water, that are not a permitted activity in section C.8.4 of the plan.	The proposal includes vegetation clearance within 10 metres of a natural wetland and river and therefore is a discretionary activity.

Table 12. Relevant rules in the RWSP

Rule	Description of the relevant activity/activities covered by the rule	Comment
22.3.1 'Stormwater discharges and diversions from land disturbance activities – discretionary activity'	The diversion and discharge of stormwater into water or onto or into land where it may enter water from any land disturbance activity, where that activity is a discretionary activity under a land disturbance activity rule in section 33 of the plan.	Earthworks and vegetation clearance activities in the Riparian Management Zone of streams within the reservoir footprint are discretionary activities. Therefore rule 22.3.1 for stormwater discharges also applies.
23.1.4(5) 'Discharges from water reservoirs – permitted activity'	The discharge of water from reservoirs or impounded areas.	Water will be discharged from the reservoir via a spillway during heavy rainfall events when the reservoir is at full capacity. It is considered that such discharges will comply with the conditions of rule 23.1.4(5). That is, the quality of the discharge is

Rule	Description of the relevant activity/activities covered by the rule	Comment
		not expected to breach the discharge and receiving water quality standards set in conditions (a) – (h) of the rule.
24.3.3 ‘All other takes – discretionary activities’	The taking, use, damming or diverting of surface water which does not meet the requirements of the permitted activity rules, or is not covered by the non-complying activity rules, and is not otherwise covered by a rule in any other section of the plan.	The damming and diversion of water by the reservoir and the taking and use of water from the reservoir is a discretionary activity in accordance with rule 24.3.3.
25.3.1 ‘Taking, use and diverting groundwater – discretionary activity’	The taking, use or diversion of groundwater from an aquifer, and any associated discharge of groundwater onto or into land or into water, which does not meet the requirements of the permitted, controlled or non-complying activity rules of the plan.	It is possible that dewatering will be required for ground improvements for the purposes of constructing the embankment of the proposed reservoir. The taking, diverting and discharge of groundwater by dewatering for ground improvement associated with the constructing the reservoir is a discretionary activity because the activities do not meet the requires of the permitted, controlled, or non-complying activity rules in the plan.
28.3.1 ‘Construction of a dam – discretionary activity’	The construction and placement of a dam structure, including the associated, damming, diversion or discharges of water in, on or under the bed of a river, that is not a provided for by another rule of the plan.	The construction of a dam on the bed of a river and the associated damming, diversion and discharges.
29.1.3 ‘Culvert crossings – permitted activity’	The use, placement, replacement, repair or alteration of a culvert crossing on the bed of a river and any associated excavation or disturbance of the bed, and diversion of water through the structure.	Te Ruaotehauhau Stream needs to be diverted during construction to provide a dry working area during construction and also to prevent the overtopping of a partially formed embankment. The intent is to construct a diversion culvert offline from the existing stream. When the culvert is completed, the stream will be diverted into the culvert, and the upstream shoulder of the dam will be preferentially constructed ahead of the downstream area, to form a cofferdam. Preliminary calculations indicate that a 1500mm to 1800mm dimeter culvert will have sufficient capacity to pass the 50-year flood. It is understood that the placement and use of the culvert will comply with the conditions of rule 29.1.3. However, it is important to note that it is not clear if the culvert design will comply with the regulation 71 of the NESFW, and because of that resource consent is being sought for the placement and use of a culvert pursuant to the regulations.
33.2.1 ‘Earthworks – controlled activity’	Earthworks, that are not located in the Riparian Management Zone not located on erosion prone land and the volume moved or disturbed is greater than 5,000 m³ in any 12-month period.	The volume of earthworks required for constructing the reservoir will exceed the thresholds in the permitted activity rules
34.3.1 ‘Land disturbance – discretionary activity’	Earthworks and vegetation clearance in Riparian Management Zone which cannot comply with, or is outside the scope of, the permitted rules, or is not a non-complying activity	Construction of the proposed reservoir will involve vegetation clearance and earthworks within the Riparian Management Zone that cannot comply with permitted nor controlled activity thresholds.

Table 13. Relevant rule in the RAQP

Rule	Description of the relevant activity/activities covered by the rule	Comments
10.1.2 'Discharges of dust to air – permitted activity'	The discharge of dust to air from activities associated with earthworks, road and rail construction or maintenance.	The proposal will comply with this rule due to the separation distance to places frequented by people.

Table 14. Relevant rules in the FNDP

Rule	Description of the relevant activity/activities covered by the rule	Comments
8.6.5.1.3 – Permitted activity	The maximum proportion of the gross site area covered by buildings and other impermeable surfaces shall be 15%	The proposed reservoir embankment is deemed a building under the FNDP. The gross area of the embankment will not exceed 15% of the site area.
8.6.5.1.7 – Permitted activity	Construction noise shall meet the limits recommended in, and shall be measured and assessed in accordance with, NZS 6803P:1984[1999] "*The Measurement and Assessment of Noise from Construction, Maintenance and Demolition Work*".	Construction noise will comply with the permitted activity standard given setback to the nearest notional boundary of a residence. Construction noise will also be managed according to best practise.
8.6.5.4 – Discretionary activity	Building height	The proposed reservoir embankment is deemed a building under the FNDP. The height of the proposed embankment (21 m) exceeds the restricted discretionary activity threshold in Rule 8.6.5.3.2 and therefore is a discretionary activity.
8.6.5.4 – Discretionary activity	Setback from boundaries	The proposed reservoir embankment will straddle a property boundary and therefore it is not permitted by Rule 8.6.5.3.4.
12.2.6.3 – Discretionary activity	Indigenous vegetation clearance	Vegetation clearance associated with constructing the proposed reservoir will not comply with Permitted Rule 12.2.6.1.1 as Clauses (a) - (o) do not apply. Vegetation clearance within 20m of streams in the reservoir footprint and identified indigenous wetlands will not meet the requirements of Permitted Rule 12.2.6.1.2.
12.3.6.3 – Discretionary activity	Excavation and filling	Excavation and filling associated with constructing the proposed reservoir will exceed the volumetric standard in rule 12.3.6.2.3 and therefore are discretionary activities.
12.7.6.3 – Discretionary	Setbacks from lakes, rivers and wetlands Preservation of indigenous wetlands	The proposal does not comply with the permitted standards for 12.7.6.1.2 'Setback from Smaller Lakes, Rivers and Wetlands' and 12.7.6.1.3 'Preservation of Indigenous Wetlands'. Furthermore, because the activity does not comply with the relevant standards for permitted, controlled or restricted discretionary activities in the zone in which it is located, set out in Part 2 of the Plan – Environment Provisions; and it does not comply with the other relevant standards for permitted, controlled or restricted discretionary activities set out in Part 3 of the Plan – District Wide Provisions, it is a discretionary activity.

5.5 Overall Activity Status

Multiple resource consents are required to authorise the construction and operation of the proposed reservoir. The resource consent applications should be 'bundled' together because the activities for which resource consents are sought overlap to such an extent that they cannot be realistically separated. A decision to 'bundle' the applications is consent with the decision of the High Court in *Newbury Holdings Ltd v Auckland Council* [2013] NZHC 1172. On this basis, the overall classification status for the proposed activity is non-complying.

5.6 Other Authorisations

Table 15 identified other activities associated with the proposal that require authorisations. All necessary authorities will be applied for at the appropriate times to avoid non-compliance.

Table 15. Other activities which require authorisations.

Activity	Classification	Relevant document	Authority
Construction of a large dam	Activity must be authorised	Building Act 2004	Waikato Regional Council[8]
To modify unrecorded subsurface archaeological sites and features which may be affected by Te Ruaotehauhau Water Storage Reservoir.	By a general authority	Heritage New Zealand Pouhere Taoonga Act 2014.	Heritage New Zealand
Transfer live aquatic animals	By permit only	Conservation Act 1987 (CAct)	DoC, Ministry for Primary Industries
Catch alive or kill any absolutely protected or partially protected wildlife for any purpose approved by the Director-General.	Activity requiring Ministers approval	Wildlife Act 1953	DoC

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[8] It is understood that all North Island councils, except Auckland Council, have transferred their powers to process all building consent applications for dams to Waikato Regional Council.

6. Statutory and Planning Assessment

Clause 2(1) of Schedule 4 of the RMA states:

> *An application for a resource consent for an activity (the* ***activity****) must include the following:*
>
> *…*
>
> *(f) an assessment of the activity against the matters set out in Part 2:*
>
> *(g) an assessment of the activity against any relevant provisions of a document referred to in section 104(1)(b).*

Clause 2(2) of Schedule 4 states:

> *The assessment under subclause (1)(g) must include an assessment of the activity against—*
>
> *(a) any relevant objectives, policies, or rules in a document; and*
>
> *(b) any relevant requirements, conditions, or permissions in any rules in a document; and*
>
> *(c) any other relevant requirements in a document (for example, in a national environmental standard or other regulations).*

An assessment of relevant rules, requirements, conditions and permissions is included in **Section 5** above.

This section provides an assessment of the matters set out in Part 2 of the Act and relevant objectives and policies in the following documents:

- The National Policy Statement for Freshwater Management 2020
- The Regional Policy Statement for Northland
- The Proposed Regional Plan for Northland (Appeals Version, 2020)
- The Regional Water and Soil Plan for Northland
- The Far North District Plan

6.1 Part 2 of the RMA

Section 5 of the RMA states:

> *(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.*
>
> *(2) In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while —*
>
> > *(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
> >
> > *(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and*
> >
> > *(c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.*

As pointed out in *Environmental Defence Society Inc. v The New Zealand King Salmon Company Ltd* [2014] NZSC 38, the term sustainable management is “broadly framed” and the language is “necessarily general and flexible.[9]

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[9] *Environmental Defence Society Inc. v The New Zealand King Salmon Company Ltd* [2014], para 24.

The Court also stated that:[10]

> *… the RMA envisages the formulation and promulgation of a cascade of planning documents, each intended, ultimately, to give effect to s 5, and to pt 2 more generally. These documents form an integral part of the legislative framework of the RMA and give substance to its purpose by identifying objectives, policies, methods and rules with increasing particularity both as to substantive content and locality.*

It is understood that the objectives, policies and rules that are relevant to this application give effect to part 2 of the RMA, although some of the relevant provisions in the PRP are the subject of appeals to the Environment Court.

Sections 6, 7, and 8 of the RMA set out principles of varying importance to give guidance on the way that the purpose of the RMA is to be achieved.

Section 6 states the following matters of national importance that must be recognised and provided for by all persons exercising functions and powers under the RMA:

(a) the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development:

(b) the protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development:

(c) the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:

(d) the maintenance and enhancement of public access to and along the coastal marine area, lakes, and rivers:

(e) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga:

(f) the protection of historic heritage from inappropriate subdivision, use, and development:

(g) the protection of protected customary rights:

(h) the management of significant risks from natural hazards.

Section 7 states the following other matters that particular regard must be had to by all persons exercising functions and powers under the RMA:

(a) kaitiakitanga:

(aa) the ethic of stewardship:

(b) the efficient use and development of natural and physical resources:

(ba) the efficiency of the end use of energy:

(c) the maintenance and enhancement of amenity values:

(d) intrinsic values of ecosystems:

(e) [Repealed]

(f) maintenance and enhancement of the quality of the environment:

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[10] Ibid, para 40.

> (g) *any finite characteristics of natural and physical resources:*
>
> (h) *the protection of the habitat of trout and salmon:*
>
> (i) *the effects of climate change:*
>
> (j) *the benefits to be derived from the use and development of renewable energy.*

Section 8 requires all persons exercising functions and powers under the RMA to take into account the principles of the Treaty of Waitangi.

It is considered that the proposal is consistent with the purpose of the RMA because it will enable people and communities to provide for their social, economic, and cultural well-being and for their health and safety by:

- Enabling land use change from pastoral farming to higher value horticultural land use, and consequential benefits to other sectors and the community.
- Improving the understanding of the history of the area, including Maori heritage and other values.

While at the same time sustaining the potential of water and soils to meet the needs of future generations, safeguarding the life-supporting capacity of water, soil and ecosystems, and avoiding, remedying and mitigating (including through offsetting and compensation) adverse effects of the proposed reservoir on the environment.

The proposal is consistent with the relevant matters of national important, i.e. section 6(a), (c), (e), and (h). The other relevant matters in section 7 are important drivers of the proposal, i.e., section 7(a), (aa), (b), (c), (d), (f), (g), and (i).

6.2 National Environmental Standards and Other Regulations

A general assessment of the relevant requirements and conditions of relevant national environmental standards and regulations is set out in **Section 5.2**.

6.3 National Policy Statement for Freshwater Management 2020

The NPS-FM was first issued in 2011, replaced in 2014, and then amended in 2017. On 3 August 2020, a new NPS-FM was approved by the Governor-General under section 52(2) of the RMA and was published by the Minister for the Environment under section 54 of the Act. The new NPS-FM replaced the NPS-FM 2014 (as amended in 2017) on 3 September 2020. The NPS-FM 2020 is structurally and, in many respects, substantively different to the NPS-FM 2014 (as amended 2017). It contains one objective (at clause 2.1) and 15 policies (at clause 2.2).

The key purpose of the NPS-FM is to direct how regional councils are to manage fresh water through their regional policy statements and regional plans.

The following assessment is made against the objective and relevant policies of the NPS-FM 2020.

The objective, which reflects the hierarchy of obligations in Te Mana o te Wai, is:

> (1) *…to ensure that natural and physical resources are managed in a way that prioritises:*
>
> > (a) *first, the health and well-being of water bodies and freshwater ecosystems*
> >
> > (b) *second, the health needs of people (such as drinking water)*
> >
> > (c) *third, the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future.*

The objective is to be achieved through 15 policies. Regard is had to policies relevant to the proposal as follows:

> ***Policy 1:*** *Freshwater is managed in a way that gives effect to Te Mana of te Wai.*

Clause 1.3 of the NPS-FM sets out the meaning of Te Mana o te Wai, which is described as:

> *…a concept that refers to the fundamental importance of water and recognises that protecting the health of freshwater protects the health and well-being of the wider environment. It protects the mauri of the wai. Te Mana o te Wai is about restoring and preserving the balance between the water, the wider environment, and the community.*

The concept involves six principles relating to the roles of tangata whenua and other New Zealanders in managing fresh water. The six principles are:

- Mana whakahaere – the power, authority, and obligations of tangata whenua to make decisions that maintain, protect, and sustain the health and well-being of, and their relationship with, freshwater.
- Kaitiakitanga – the obligation of tangata whenua to preserve, restore, enhance, and sustainably use freshwater for the benefit of present and future generations.
- Manaakitanga – the process by which tangata whenua show respect, generosity, and care for freshwater and for others.
- Governance – the responsibility of those with authority for making decisions about freshwater to do so in a way that prioritises the health and well-being of freshwater now and into the future.
- Stewardship – the obligation of all New Zealanders to manage freshwater in a way that ensures it sustains present and future generations.
- Care and respect – the responsibility of all New Zealanders to care for freshwater in providing for the health of the nation.

The applicant has had meaningful engagement with tangata whenua (refer **Section 8**), and the applicant recognises the fundamental importance of the principles of mana whakahaere, kaitiakitanga, and manaakitanga.

The applicant commissioned the Resource Management Unit (RMU) of the Taiāmai ki te Takutai Moana[11] to prepare a cultural impact assessment on behalf of Ngā Hapū. It will include evidence from Te-Rūnanga-ā-Iwi-o-Ngāpuhi that the cultural impact assessment is also prepared on behalf of the Iwi Authority as is required under the Act (refer **Section 8.3**)

The assessment had not been completed at the time of lodging this application. However, it is understood that it will be available for the consent authority to consider for the purposes of making a decision on this application.

Clause 1.3 of the NPS-FM 2020 states:

> *There is a hierarchy of obligations in Te Mana o te Wai that prioritises:*
>
> *(a) first, the health and well-being of water bodies and freshwater ecosystems*
>
> *(b) second, the health needs of people (such as drinking water)*
>
> *(c) third, the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future.*

It is considered that the proposal to construct and operate Te Ruaotehauhau Water Storage Reservoir is consistent with hierarchy of obligation in Te Mana o te Wai. That is because the project will ensure flows below

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[11] Taiāmai ki te Takutai Moana is a charitable trust that represents all hapū of Taiāmai ki te Marangai that tātai to the whenua for the purposes of the RMA.

the dam are maintained to the extent needed to the ecological health of Te Ruaotehauhau Stream and it will involve a comprehensive suite of mitigation, offsetting and compensation measures to maintain and improve the health of aquatic (and terrestrial ecosystems) in the area.

The key purpose of the project is to improve the social and economic well-being of communities in the Kaipara District by providing sufficient and reliable water for converting pastoral farming to horticulture.

> ***Policy 2:*** *Tangata whenua are actively involved in freshwater management (including decision-making processes), and Māori freshwater values are identified and provided for.*

The applicant has attempted to undertake meaningful engagement with tangata whenua and intends to continue involving Rūnanga-ā-Iwi-o-Ngāpuhi and Taiāmai ki te Takutai Moana, which is a charitable trust that represents all the hapū of Taiāmai ki te Marangai that tātai to the whenua for the purposes of the RMA

It is understood that the cultural impact assessment, which had not been finalised at the date of lodgement, will contain recommendations on how mana whenua should be actively involved in the project moving forward.

> ***Policy 3:*** *Freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments.*

This application considers the interconnected nature of the catchment upstream of the proposed reservoir embankment and the actual and potential effects of the proposed reservoir on the surrounding land use and downstream receiving environments. The applicant is also proposing a comprehensive suite of mitigation, offsetting and compensation measures to achieve a no net loss for ecological values affected by the project.

> ***Policy 4:*** *Freshwater is managed as part of New Zealand's integrated response to climate change.*

It is considered that the proposed reservoir will improve resilience to the effects of climate change, including predicted more frequent and longer droughts. The availability of reliable water is necessary for social, cultural and economic reasons and for the health and safety of people, particularly in the context of a changing climate. It is also important to note that the proposed water storage reservoir will provide flood attenuation benefits.

> ***Policy 6:*** *There is no further loss of extent of natural inland wetlands, their values are protected, and their restoration is promoted.*

Constructing the reservoir will inundate 0.03 hectares of natural wetland (as defined in the NPS-FM). A description of the wetland is contained in the ecological assessment of effects report (**Appendix G**). In summary, the natural wetland present on the site is a small section of rautahi (*Carex geminata*) dominated wetland, which is compromised by stock grazing and hydrological modification. The proposed reservoir was one of several sites shortlisted from approximately 100 sites due to, in part, the need to avoid significant indigenous wetlands (as defined in the Proposed Regional Plan for Northland).

The applicant proposes to offset and compensate for the loss of the natural wetland. Based on preliminary offset and compensation, they consider that approximately 0.08 hectares of wetland offset planting (on land that was historically wetland) is required to achieve a net gain. The project is also expected to create new wetlands in the gullies draining to the reservoir. The construction of the reservoir will result in the creation of edge wetland habitat for native wetland birds. The ecological assessment report confirms "management plans will be required prior to construction in order to remedy, offset and compensate impacts to vegetation and habitats."

It is considered that the mitigation, offsetting and compensation measures will not result in a loss of extent of natural inland wetlands, and that their values will be retained, and it will achieve restoration of historic wetlands that have been destroyed. It is noted that Policy 6 is about "loss of **extent** of natural inland wetlands", not 'loss of natural inland wetlands'.

> ***Policy 7:*** *The loss of river extent and values is avoided to the extent practicable.*

The proposed reservoir will inundate the gully system resulting in modification of approximately 2,114 m (approximately 5,285 m^2 streambed) of continually flowing stream and approximately 538 m (approximately 108 m^2) of intermittently flowing streams. The stream habitat is considered to have high ecological value.

The ecological assessment report states that “approximately 12,671 m^2 and 634 m^2 (collectively 13,305 m^2) of similar permanent and intermittent streambed area habitat enhancement in nearby catchments in Kaikohe is required to achieve no net loss of ecological function.” The applicant proposes that such enhancement be required as a condition of resource consent.

> ***Policy 9:*** *The habitats of indigenous freshwater species are protected.*

Almost all-natural waterbodies are habitats of indigenous freshwater species. While the proposed reservoir will inundate approximately 0.03 ha of natural wetland and watercourses, the proposal involves mitigation, offsetting and compensation measures to achieve no net loss12. It is also important to note that passage will be provided for eels over the reservoir embankment, which will mean their existing habitat is protected.

> ***Policy 11:*** *Freshwater is allocated and used efficiently, all existing over-allocation is phased out, and future over-allocation is avoided.*

The proposal involves damming (i.e., storing) water which will be taken and used primarily for supporting horticulture development in the area. The proposal will not result in over-allocation (as defined in the NPS-FM). That is, the proposal will not exceed a take limit in the PRP.

> ***Policy 15:*** *Communities are enabled to provide for their social, economic, and cultural well-being in a way that is consistent with this National Policy Statement.*

Policy 15 of the NPS-FM encapsulates the purpose of the proposal (as described elsewhere in this application).

6.4 Regional Policy Statement for Northland 2016

The RPS was made operative in 2016. The RPS contains several objectives and policies that are relevant to the consideration of the proposal. It is important to note that regard is only had to provisions that have not been implemented through the PRP or FNDP. The provisions are grouped by resource management topics as follows.

6.4.1 Freshwater Quantity

The freshwater quantity management provisions in the RPS is consistent with the direction in the NPS-FM 2020 and have for the most part been implemented through the PRP. However, Policy 4.3.4 stresses the importance of water storage. Policy 4.3.4 is to “recognise and promote the benefits of water harvesting, storage and conservation”.

The explanation to the policy states:

> *Security and reliability of supply can be increased by harvesting and storing water for distribution and use during shortages.*
>
> *Water harvesting, storage, and conservation can improve the efficient allocation and use of water. These measures will become increasingly important – particularly in Northland because of its many short catchments – as demand for water increases and the local climate changes with longer dry spells and more frequent high intensity rain events. Water storage measures can also have other benefits such as buffering storm flows, recharging aquifers, creating habitat and improving recreational opportunities.*
>
> *Policy 4.3.4 is an important consideration for decision-makers when assessing applications for resource consents and changing regional and district plans.*

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[12] Means that the measurable positive effects of actions exceed the point of no net loss. (NPS-FM)

The proposal has come about because of the demand for sufficient reliable water in the area. It is acknowledged that the reservoir will have other positive benefits, including buffering storm flows and creating habitat for indigenous fauna.

6.4.2 Water Quality

Objective 3.2 seeks to improve the overall quality of Northland's fresh and coastal waters, with a particular emphasis on the trophic level of lakes, macroinvertebrate communities in rivers, sedimentation rates in estuaries and harbours, human health. Policy 4.2.1 of the RPS sets out how the objective is to be achieved:

> *Improve the overall quality of Northland's water resources by:*
>
> (a) *Establishing freshwater objectives and setting region-wide water quality limits in regional plans that give effect to Objective 3.2 of this regional policy statement.*
>
> (b) *Reducing loads of sediment, nutrients, and faecal matter to water from the use and development of land and from poorly treated and untreated discharges of wastewater; and*
>
> (c) *Promoting and supporting the active management, enhancement and creation of vegetated riparian margins and wetlands.*

It is considered that the proposal will help achieve Policy 4.2.1 and in turn Objective 3.2. The water storage reservoir will enable the conversion of land used for pastoral farming to horticulture, and in doing so it is likely to result in a reduction of losses of sediment and faecal matter to water. The proposed comprehensive suite of mitigation, offsetting and compensation measures will involve active management, enhancement and creation of riparian margins and wetlands, which should in turn have localised positive impacts on water quality.

6.4.3 Indigenous Ecosystems and Biodiversity

Objective 3.4 is to:

> *Safeguard Northland's ecological integrity by:*
>
> a) *Protecting areas of significant indigenous vegetation and significant habitats of indigenous fauna;*
>
> b) *Maintaining the extent and diversity of indigenous ecosystems and habitats in the region; and*
>
> c) *Where practicable, enhancing indigenous ecosystems and habitats, particularly where this contributes to the reduction in the overall threat status of regionally and nationally threatened species.*

The objective is to be achieved through several policies, of which Policy 4.4.1 is directly relevant. Policy 4.4.1 is very similar to D.2.16 of the PRP. A key difference is the former applies to terrestrial and aquatic ecosystems and the latter applies only to terrestrial ecosystems. Policy 4.4.1 is:

> (1) *In the coastal environment, avoid adverse effects, and outside the coastal environment avoid, remedy or mitigate adverse effects of subdivision, use and development so they are no more than minor on:*
>
> > (a) *Indigenous taxa that are listed as threatened or at risk in the New Zealand Threat Classification System lists;*
> >
> > (b) *Areas of indigenous vegetation and habitats of indigenous fauna, that are significant using the assessment criteria in Appendix 5;*
> >
> > (c) *Areas set aside for full or partial protection of indigenous biodiversity under other legislation.*
>
> …
>
> (3) *Outside the coastal environment and where clause (1) does not apply, avoid, remedy or mitigate adverse effects of subdivision, use and development so they are not significant on any of the following:*

> (a) *Areas of predominantly indigenous vegetation;*
>
> (b) *Habitats of indigenous species that are important for recreational, commercial, traditional or cultural purposes;*
>
> (c) *Indigenous ecosystems and habitats that are particularly vulnerable to modification, including wetlands, dunelands, northern wet heathlands, headwater streams, floodplains and margins of freshwater bodies, spawning and nursery areas.*

> (4) *For the purposes of clause (1), (2) and (3), when considering whether there are any adverse effects and/or any significant adverse effects:*
>
> (a) *Recognise that a minor or transitory effect may not be an adverse effect;*
>
> (b) *Recognise that where the effects are or maybe irreversible, then they are likely to be more than minor;*
>
> (c) *Recognise that there may be more than minor cumulative effects from minor or transitory effects.*
>
> (5) *For the purpose of clause (3) if adverse effects cannot be reasonably avoided, remedied or mitigated then it maybe appropriate to consider the next steps in the mitigation hierarchy i.e. biodiversity offsetting followed by environmental biodiversity compensation, as methods to achieve Objective 3.4.*

The site of the proposed reservoir is not located in the coastal environment. The ecological assessment report (refer **Appendix F**) identified three longfin eel in streams within the reservoir footprint. The presence of longfin eel, an At Risk – Declining species, at the site meets the 'rarity/distinctiveness criteria' within Appendix 5 of the RPS, and therefore the stream channels within the footprint area classified as a 'significant habitat of indigenous fauna'. The proposal includes providing for upstream and downstream passage of longfin eels, which will mitigate adverse effects on their habitat so the effects will be no more than minor.

The footprint of the proposed reservoir also contains threatened species, i.e., kānuka and rātā vines (due to the threat of myrtle rust) and swamp maire, and at risk species, i.e., manuka (also due to the threat of myrtle rust). A comprehensive suite of mitigation, offsetting and compensation measures are proposed to ensure that there are no more than minor adverse effects on the threatened and at-risk taxa.

There is a small section of rautahi wetland (approximately 0.03 ha) that will be inundated by the reservoir. It is proposed that a Offset and Compensation Plan is prepared and implemented as a requirement of a condition of consent (refer **Appendix J**). It will involve restoration planting and habitat enhancement of approximately 0.08 ha of similar wetland type. It is considered that this consistent with clause 5 of Policy 4.4.1.

6.4.4 Natural Character, Features, Landscapes

Objective 3.14 is:

> *Identify and protect from inappropriate subdivision, use and development;*
>
> (a) *The qualities and characteristics that make up the natural character of the coastal environment, and the natural character of freshwater bodies and their margins;*
>
> (b) *The qualities and characteristics that make up outstanding natural features and outstanding natural landscapes;*
>
> (c) *The integrity of historic heritage.*

The objective is to be achieved through several policies, of which Policy 4.6.1 is directly relevant:

> …
>
> (2) *Outside the coastal environment avoid significant adverse effects and avoid, remedy or mitigate other adverse effects (including cumulative adverse effects) of subdivision, use and development on the characteristics and*

> *qualities of outstanding natural features and outstanding natural landscapes and the natural character of freshwater bodies. Methods which may achieve this include: …*
>
> *(a) Minimising, indigenous vegetation clearance and modification (including earthworks / disturbance and structures) to natural wetlands, the beds of lakes, rivers and their margins.*

The construction of the proposed reservoir will result in the inundation of rivers (streams). It is considered that the natural character of the streams within the reservoir footprint need to be considered within the context of the broader catchment. The applicant proposes to enhance the habitat of streams in other parts of the catchment or nearby catchments through planting riparian margins as part of a Offset and Compensation Plan. The riparian margins of the reservoir will also be planted with native vegetation. It is considered that this will avoid, or at least minimise, adverse effects on the natural character of freshwater bodies in the area.

The landscape and visual amenity assessment report (refer **Appendix G**) states that:

> *Overall, the stream is determined to display a moderate level of natural character, noting that for much of its length, it flows within a modified pastoral landscape.*
>
> *The proposal will result in the loss of a modification of approximately 2,114 m of continually flowing permanent stream and approximately 538m of intermittently flowing stream. The filling of the reservoir will impact the main stems and tributaries across the site, turning them from relatively natural, hard-bottom streams to lake type habitat.*
>
> *The [assessment of ecological effects report] concludes that the potential adverse effects resulting from the proposal on freshwater ecosystems and fauna can be mitigated through implementation of management plans and residual adverse effects addressed through offset or compensation measures on similar habitats in the wider catchment.*
>
> *The change in relation to the experiential and perceptual attributes of natural character will be limited in magnitude, given the separation between potential viewers and the Site. Individuals will recognise a change as a result of the loss of riparian vegetation, but within the wider landscape context, this change will be small. Overall, it is the opinion of the author that the potential adverse natural character effect of the proposal will be low, once the offset or compensation measures have been implemented.*

6.4.5 Active Management and Improvement

Objective 3.15 is:

> *Maintain and/or improve:*
>
> *(a) The natural character of the coastal environment and fresh water bodies and their margins;*
>
> *(b) Outstanding natural features and outstanding natural landscapes;*
>
> *(c) Historic heritage;*
>
> *(d) Areas of significant indigenous vegetation and significant habitats of indigenous fauna (including those within estuaries and harbours);*
>
> *(e) Public access to the coast; and*
>
> *(f) Fresh and coastal water quality*
>
> *by supporting, enabling and positively recognising active management arising from the efforts of landowners, individuals, iwi, hapū and community groups.*

The explanation to the objective states, among other things, that “appropriate subdivision, use and development can be the most effective means to achieve on-going management and improvement of these resources and can provide opportunities to address ongoing impacts / risks and result in net positive effects that may not otherwise occur."

Policy 4.7.1 seeks that beneficial effects of active management be given due weight in decision-making:

> *In plan provisions and the resource consent process, recognise and promote the positive effects of the following activities that contribute to active management:*
>
> *(a) Pest control, particularly where it will complement an existing pest control project / programme;*
>
> *(b) Soil conservation / erosion control;*
>
> *(c) Measures to improve water quality in parts of the coastal marine area where it has deteriorated and is having significant adverse effects, or in freshwater bodies targeted for water quality enhancement;*
>
> *(d) Measures to improve flows and / or levels in over allocated freshwater bodies;*
>
> *(e) Re-vegetation with indigenous species, particularly in areas identified for natural character improvement;*
>
> *(f) Maintenance of historic heritage resources (including sites, buildings and structures);*
>
> *(g) Improvement of public access to and along the coastal marine area or the margins of rivers or lakes except where this would compromise the conservation of historic heritage or significant indigenous vegetation and / or significant habitats of indigenous fauna;*
>
> *(h) Exclusion of stock from waterways and areas of significant indigenous vegetation and / or significant habitats of indigenous fauna;*
>
> *(i) Protection of indigenous biodiversity values identified under Policy 4.4.1, outstanding natural character, outstanding natural landscapes or outstanding natural features either through legal means or physical works;*
>
> *(j) Removal of redundant or unwanted structures and / or buildings except where these are of historic heritage value or where removal reduces public access to and along the coast or lakes and rivers;*
>
> *(k) Restoration or creation of natural habitat and processes, including ecological corridors in association with indigenous biodiversity values identified under Policy 4.4.1, particularly wetlands and / or wetland sequences;*
>
> *(l) Restoration of natural processes in marine and freshwater habitats.*

As stated previously, the applicant is proposing to prepare and implement an Offset and Compensation Plan, as a condition of consent, to address residual adverse effects on aquatic and terrestrial ecosystems and habitats. While the plan has not been prepared at this time, it is envisaged that it will address planting and pest and weed control, with associated improvements to the natural character of the area.

6.4.6 Infrastructure

Objective 3.7 is to "recognise and promote the benefits of regionally significant infrastructure, (a physical resource), which through its use of natural and physical resources can significantly enhance Northland's economic, cultural, environmental and social wellbeing."

While the proposed reservoir is not explicitly identified as regionally significant infrastructure in Appendix 3 of the RPS, it will provide considerable public benefits to the extent that it warrants consideration as regionally significant infrastructure.

Objective 3.8 is:

> *Manage resource use to:*

> *(a) Optimise the use of existing infrastructure;*
>
> *(b) Ensure new infrastructure is flexible, adaptable, and resilient, and meets the reasonably foreseeable needs of the community; and*
>
> *(c) Strategically enable infrastructure to lead or support regional economic development and community wellbeing.*

Policy 5.2.3 is to "promote the provision of infrastructure as a means to shape, stimulate and direct opportunities for growth and economic development." This application demonstrates that the proposal will lead and support regional economic development and community wellbeing.

6.4.7 Other

Objective 3.5 is that "Northland's natural and physical resources are sustainably managed in a way that is attractive for business and investment that will improve the economic wellbeing of Northland and its communities." The proposed reservoir, as part of the Mid-North Water Scheme, will attract investment in high value horticulture development and improve economic and social wellbeing.

6.5 Proposed Regional Plan for Northland (Appeals Version) June 2020

In September 2017, NRC notified the PRP. The PRP replaces three existing regional plans[13]. In April 2019, NRC accepted and adopted the recommendations of an independent hearing panel of decisions on provisions and matters raised in submissions. Several provisions in the PRP are the subject of appeals to the Environment Court.

The RMA does not distinguish between weights to be given to an operative plan and a proposed plan. Case law has established that relevant factors in determining weight include the extent to which the proposed measure has been subject to independent decision-making, possible injustice to the applicant or others, and the extent to which a new measure, or absence of one, may implement a coherent pattern of objectives and policies in a plan.[14]

In this assessment, where there same or similar provisions in the PRP and the RWS regard it only had to the provisions in the PRP.

6.5.1 Tangata Whenua

Objective F.1.8 is that "[t]angata whenua's kaitiaki role is recognised and provided for in decision-making over natural and physical resources." Policies D.1.1 – D.1.5 provide for the achievement of the objective.

Policy D.1.1 states:

> *A resource consent application must include in its assessment of environmental effects an analysis of the effects of an activity on tangata whenua and their taonga if one or more of the following is likely:*
>
> *1) adverse effects on mahinga kai or access to mahinga kai, or*
>
> *2) any damage, destruction or loss of access to wāhi tapu, sites of customary value and other ancestral sites and taonga with which Māori have a special relationship, or*
>
> *3) adverse effects on indigenous biodiversity in the beds of waterbodies or the coastal marine area where it impacts on the ability of tangata whenua to carry out cultural and traditional activities, or*
>
> *4) the use of genetic engineering and the release of genetically modified organisms to the environment, or*

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[13] Regional Air Quality Plan for Northland (operative March 2003), Regional Coastal Plan for Northland (operative July 2004) and Regional Water and Soil Plan for Northland (operative August 2004).

[14] *Keystone Ridge Ltd v Auckland CC* HC Auckland AP24/01

> 5) *adverse effects on tāiapure, mataitai or Māori non-commercial fisheries, or*
>
> 6) *adverse effects on protected customary rights, or*
>
> 7) *adverse effects on sites and areas of significance to tangata whenua mapped in the Regional Plan (refer I Maps |Ngā mahere matawhenua).*

The site of the proposed reservoir has rich cultural heritage and contains sites of customary value and ancestral sites, as documented in the archaeological assessment report (refer **Appendix H**). Based on literature and engagement with local whanau and hapū, it is clearly obvious that the area is highly valued by mana whenua. Furthermore, it is understood that Te Ruaotehauhau Stream is valued for mahinga kai.

The Resource Management Unit (RMU) of Taiāmai ki te Takutai Moana is preparing a cultural impact assessment on behalf of mana whenua and it will include evidence from Te-Rūnanga-ā-Iwi-o-Ngāpuhi that the assessment is also prepared on behalf of the Iwi Authority as is required under the Act. See **Section 8.3** for further information. The assessment will contain an analysis of the effects of the proposal on tangāta whenua and their taonga.

6.5.2 Freshwater Quantity

Objective F.1.1 is:

> *Manage the taking, use, damming and diversion of fresh water so that:*
>
> 1) *the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems of fresh water are safeguarded and the health of freshwater ecosystems is maintained, and*
>
> 2) *the significant values, including hydrological variation in outstanding freshwater bodies and natural wetlands are protected, and*
>
> 3) *the extent of littoral zones in lakes are maintained, and*
>
> 4) *rivers have sufficient flows and flow variability to maintain habitat quality, including to flush rivers of deposited sediment and nuisance algae and macrophytes and support the natural movement of indigenous fish and valued introduced species such as trout, and*
>
> 5) *flows and water levels support sustainable mahinga kai, recreational, amenity and other social and cultural values associated with freshwater bodies, and*
>
> 6) *adverse effects associated with saline intrusion and land subsidence above are avoided (except where the taking, use, damming or diversion is for groundwater management at the Marsden Point refinery, in which case this clause does not apply), and*
>
> 7) *it is a reliable resource for consumptive and non-consumptive uses.*

It is considered that that the proposal to divert and dam water behind the proposed reservoir embankment meets the objective. The assessment of hydrological effects (refer **Appendix C**) demonstrates that reservoir will have minimal effects on downstream hydrological variation, and based on the assessment of ecological effects (refer **Appendix F**) it is considered that the aquatic ecosystem health of the Te Ruaotehauhau Stream will be maintained. The reservoir will provide a reliable resource for consumptive water use.

Policy D.4.10 reinforces the direction in the NPS-FM to avoid over-allocation :

> *For the purpose of assisting with the achievement of Objective F.1.1 of this Plan:*
>
> 1) *apply the allocation limits set in H.4 Environmental flows and levels when considering and determining applications for resource consents to take, use, dam or divert fresh water, and*

2) *ensure that no decision will likely result in over-allocation.*

Over-allocation is defined in the NPS-FM as "…the situation where: (a) resource use exceeds a limit; or (b) if limits have not been set, an FMU or part of an FMU is degraded or degrading". A "limit means either a limit on resource use or a take limit". The allocation limits in Policy H.4.3 of the PRP were set in accordance with the NPS-FM 2014 (as amended 201&), which has been replaced. That said, the allocation limits are effectively take limits.

The allocation limits specify the maximum quantity fresh water that can be taken, dammed, or diverted from a river when the flow in the river is between the minimum flow and median flow. The limits do not apply to the taking, damming of diverting flows above the median flow. Policy H.4.3, which is the subject of an appeal to the Environment Court, is:

1) *The quantity of fresh water that can be taken from a river at flows below the median flow must not exceed whichever is the greater of the following limits:*
    a) *the relevant limit in Table 26: Allocation limits for rivers, or*
    b) *the quantity authorised to be taken by:*
        i. *resource consents existing at the date of public notification of this Plan less, with the exception of water permits for takes from rivers in the Mangere Catchment, any resource consents subsequently surrendered, lapsed, cancelled or not replaced, and*
        ii. *takes that existed at the notification date of this Plan that are subsequently authorised by resource consents under: Rule C.5.1.8 Replacement water permits for registered drinking water supplies – controlled activity, Rule C.5.1.9 Takes existing at the notification date of the plan – controlled activity and Rule C.5.1.11 Takes existing at the notification date of this Plan – discretionary activity.*
2) *The allocation limits specified in Clause 1) include volumes allowed to be taken under section 14(3)(b) of the RMA and permitted to be taken by rules in this Plan, and the estimated or measured volumes associated with such takes should be considered when making decisions on applications water permits.*
3) *The allocation limits specified in Clause 1) apply to applications for water permits for the taking and use of fresh water from rivers, but do not apply to non-consumptive components of takes.*

Table 26: Allocation limits for rivers

River water quantity management unit	*Allocation limit (m3/day)*
Outstanding rivers	*10 percent of the seven-day mean annual low flow*
Coastal rivers	*30 percent of the seven-day mean annual low flow*
Small rivers	*40 percent of the seven-day mean annual low flow*
Large rivers	*50 percent of the seven-day mean annual low flow*

The proposal is to dam the available 'core' allocation outside of the irrigation season (i.e., during winter months) and dam water above the minimum flow. The stored water will be taken and used for supporting horticulture development. It is considered that the taking and use of the stored water will not exceed 40% of the 7-day MALF.

Policy D.4.12 directs decision-makers to apply the minimum flows and levels in Policies H.4.1 and H.4.2 of the PRP when making decisions on applications for activities that require water permits. The policy, which is the subject of appeals to the Environment Court, is:

1) *For the purpose of assisting with the achievement of Objective F.1.1 of this Plan, ensure that the minimum flows and levels in H.4 Environmental flows and levels apply to activities that require water permits pursuant to rules in this Plan, and*

2) *Notwithstanding this general requirement, for rivers an alternative minimum flow (comprising the minimum flow set in H.4 Environmental flows and levels less a specified rate of flow particular to an activity) may be applied where the water is to be taken, dammed or diverted for:*

   a) *the health of people as part of a registered drinking water supply, or*

   b) *root stock survival water, or*

   c) *an individual's reasonable domestic needs or the reasonable domestic needs of a person's animals for drinking water that is, or is likely to be, having an adverse effect on the environment and is not permitted by a rule in this Plan, or*

   d) *a non-consumptive take*.

The proposed reservoir will provide for a continuation flow through the reservoir that will exceed (i.e., have a greater flow rate) than the specified minimum flow (90% 7-day Mean Annual Low Flow) for 'small rivers' set in Policy H.4.1. **Table 16** sets out the minimum flow criteria that apply.

Table 16. Proposed damming of catchment inflows and designed continuation flows.

Damming type	Rate (L/s)	Minimum flow criteria (L/s)	Note
High-flow damming	0 - 451	29	Catchment inflow from median to median plus 2x Std Dev
Core allocation ('low flow') damming	3.0	5.9	Catchment inflow during winter only

Policies D.4.13 and D.4.14 require applicants for resource consents for the taking and use of water for irrigation and community water supplies, respectively, to demonstrate that the sought volumes are reasonable and that the water will be used efficiently. It is important to note that while the intended purposes are known, supply agreements are not in place. The applicant considers that it is appropriate to grant resource consent to take the stored water for future horticulture development in the command area.

The applicant proposes that as a condition of consent the consent holder must prepare, and keep regularly updated, a Water Supply Management Plan that will include:

- A general policy on how decisions will be made to supply water to persons from the scheme;
- Identification of allocation quantities to persons as set out under Water Supply Agreements;
- Responsibilities of persons receiving the water to ensure water is conveyed and used efficiently, including the following considerations:
- Responsibilities of persons receiving the water to ensure water is conveyed and used efficiently, including the following considerations: (a) an assessment of the demonstrated need for water, including current and likely future demand; and (b) implementation of industry good management practices[15], taking into account the nature of the activity, to efficiently use water

Policy D.4.19 is a transitional direction included in the PRP pursuant to the requirement of Policy B7 of the NPS-FM (2014 (as amended 2017). The policy is:

1) *When considering any application the consent authority must have regard to the following matters:*

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[15] For example, Irrigation Design Code of Practice and Standards and Irrigation Installation Code of Practice (Irrigation NZ), and Piped Irrigation System Performance Assessment Code of Practice (Irrigation NZ)

> a) *the extent to which the change would adversely affect safeguarding the life-supporting capacity of fresh water and of any associated ecosystem and*
>
> b) *the extent to which it is feasible and dependable that any adverse effect on the life-supporting capacity of fresh water and of any associated ecosystem resulting from the change would be avoided.*
>
> 2) *This policy applies to:*
>
> a) *any new activity and*
>
> b) *change in the character, intensity or scale or any established activity –*
>
> *that involves any taking, using, damming or diverting of fresh water or draining of any wetland which is likely to result in any more than minor adverse change in the natural variability of flows or level of any fresh water, compared to that which immediately preceded the commencement of the new activity or the change in the established activity (or in the case of a change in an intermittent or seasonal activity, compared to that on the last occasion on which the activity was carried out).*

It is considered that the proposed reservoir will not result in a more than minor adverse change in the natural variability of flows in the Te Ruaotehauhau Stream. The effect of the proposed reservoir on downstream flows dissipates rapidly with distance. See Section 7.1 the assessment of hydrological effects (refer **Appendix C**).

Despite that conclusion, the actual and potential effects of the proposed reservoir on aquatic and associated ecosystems has been assessed, and measures have been proposed to avoid, remedy and mitigate adverse effects.

6.5.3 Water Quality

Policy D.4.26 is:

> *When assessing an application for resource consent for an earthworks, vegetation clearance or land preparation activity and associated discharge of a contaminant, ensure that the activity:*
>
> 1) *will be done in accordance with established good management practices, and*
>
> 2) *avoids significant adverse effects, and avoids, remedies or mitigates other adverse effects on:*
>
> a) *drinking water supplies, and*
>
> b) *areas of high recreational use, and*
>
> c) *aquatic ecosystem health, indigenous biodiversity in water bodies and coastal water and receiving environments that are sensitive to sediment or phosphorus accumulation.*

The construction of the proposed reservoir will be done in accordance with established erosion and sediment control practices (i.e., the Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region). The applicant proposes that an ESCMP, part of a CEMP, be prepared and implemented as a condition of resource consent (refer **Appendix J**).

6.5.4 Indigenous Ecosystems and Biodiversity

Objective F.1.3 is very similar to Objective 3.4 of the RPS and is the subject of an appeal to the Environment Court. The objective is:

> *In the coastal marine area and in fresh waterbodies, safeguard ecological integrity by:*
>
> 1) *protecting areas of significant indigenous vegetation and significant habitats of indigenous fauna, and*

> 2) *maintaining regional indigenous biodiversity, and*
>
> 3) *where practicable, enhancing and restoring indigenous ecosystems and habitats to a healthy functioning state, and reducing the overall threat status of regionally and nationally Threatened or At Risk species, and*
>
> 4) *preventing the introduction of new marine or freshwater pests into Northland and slowing the spread of established marine or freshwater pests within the region.*

Policy D.2.16 is the main policy by which Objective F.1.3 will be achieved. The policy, which is also the subject of an appeal to the Environment Court and very similar Policy 4.4.1 of the RPS, is:

> *Manage the adverse effects of activities on indigenous biodiversity by:*
>
> …
>
> 2) *outside the coastal environment:*
>
>   a) *avoiding, remedying or mitigating adverse effects so they are no more than minor on:*
>
>   i. *indigenous taxa that are listed as Threatened or At Risk in the New Zealand Threat Classification System lists, and*
>
>   ii. *areas of indigenous vegetation and habitats of indigenous fauna, that are significant using the assessment criteria in Appendix 5 of the Regional Policy Statement, and*
>
>   iii. *areas set aside for full or partial protection of indigenous biodiversity under other legislation, and*
>
>   b) *avoiding, remedying or mitigating adverse effects so they are not significant on:*
>
>   i. *areas of predominantly indigenous vegetation, and*
>
>   ii. *habitats of indigenous species that are important for recreational, commercial, traditional or cultural purposes, and*
>
>   iii. *indigenous ecosystems and habitats that are particularly vulnerable to modification, including wetlands, wet heathlands, headwater streams, spawning and nursery areas, and*
>
> …
>
> 5) *assessing the potential adverse effects of the activity on identified values of indigenous biodiversity, including by:*
>
>   a) *taking a system-wide approach to large areas of indigenous biodiversity such as whole estuaries or widespread bird and marine mammal habitats, recognising that the scale of the effect of an activity is proportional to the size and sensitivity of the area of indigenous biodiversity, and*
>
>   b) *recognising that existing activities may be having existing acceptable effects, and*
>
>   c) *recognising that discrete, localised or otherwise minor effects impacting on the indigenous biodiversity may be acceptable, and*
>
>   d) *recognising that activities with transitory effects may be acceptable, and*
>
> 6) *recognising that appropriate methods of avoiding, remedying or mitigating adverse effects may include:*
>
>   a) *careful design, scale and location proposed in relation to areas of indigenous biodiversity, and*
>
>   b) *maintaining and enhancing connections within and between areas of indigenous biodiversity, and*

c) considering the minimisation of effects during sensitive times such as indigenous freshwater fish spawning and migration periods, and

d) providing adequate setbacks, screening or buffers where there is the likelihood of damage and disturbance to areas of indigenous biodiversity from adjacent use and development, and

e) maintaining the continuity of natural processes and systems contributing to the integrity of ecological areas, and

f) the development of ecological management and restoration plans, and

7) recognising that significant residual adverse effects on biodiversity values can be offset or compensated:

a) in accordance with the Regional Policy Statement for Northland Policy 4.4.1, and

b) after consideration of the methods in (6) above, and

8) recognising the benefits of activities that:

a) include the restoration and enhancement of ecosystems, habitats and indigenous biodiversity, and

b) improve the public use, value or understanding of ecosystems, habitats and indigenous biodiversity.

It is considered that the proposal is consistent with Policy D.4.16. The relevant parts of clause (1) are addressed above in **Section 6.4.3** with respect to Policy 4.4.1 of the RPS.

The applicant proposes that the following plans to manage ecological effects are prepared and implemented in accordance with a condition of a resource consent:

- Freshwater Fauna and Salvage Relocation Plan – It will detail the measures to salvage and relocate native freshwater fish and kewai
- Offset and Compensation Plan to address residual adverse effects on both freshwater and terrestrial environments – It will detail the quantum and nature of planting or other compensation measures required to account for a loss of terrestrial and wetland habitats, including planting of woody riparian vegetation to enhance streams in the area
- Bat Management Plan – It will detail management measures to avoid, minimise or mitigate potential impacts to long-tail bats, including best-practice vegetation removal protocols, planting of tree species which may form roost habitat over time, planting of suitable species to replace the loss of foraging/commuting habitat within the affected area, and/or pest control to protect root habitat off site.
- Avifauna Management Plan – It will detail management measures to avoid, minimise or mitigate potential impacts to avifauna, including vegetation removal protocols and timing, and wetland bird management and bird nest check protocols.
- Lizard Management Plan – It will detail management measures to avoid, minimise or mitigate potential impacts to skinks and geckos, including species to be targeted, salvaging methodology, relocation site characteristics and location, for example.
- Invertebrate Management Plan – It will detail management measures to avoid, minimise or mitigate potential impacts to snails. Kauri snails will be managed through destructive habitat searching prior to vegetation clearance.

Policy D.4.22 provides policy direction on how activities that affect natural wetlands should be managed:

Activities affecting a natural wetland:

1) should maintain the following important functions and values of wetlands, including:

> a) *water purification and nutrient attenuation, and*
>
> b) *contribution to maintaining stream flows during dry periods, and*
>
> c) *peak stream flow reduction, and*
>
> d) *providing habitat for indigenous flora and fauna, including ecological connectivity to surrounding habitat, and*
>
> e) *recreation, amenity and natural character values, and*
>
> 2) *must avoid, remedy, or mitigate adverse effects on important wetland functions and values, or*
>
> 3) *must provide biodiversity off-setting or environmental biodiversity compensation, so that residual adverse effects on the important functions and values of wetlands are no more than minor.*

The area of natural wetland within the reservoir footprint is small (0.03 ha). The proposed reservoir provides the important functions and values of wetlands listed in the first clause of the policy. That is, it will provide water quality improvement functions (e.g., attenuating fine sediments and nutrients); contribute to maintaining stream flows during dry periods; reduce peak flows; provide habitat for indigenous flora and fauna; and will have positive amenity and natural character values. The proposal also involves biodiversity offsetting and ecological compensation.

Policy D.4.23 provides further directs decision-makers when considering applications for activities that affect wetlands:

> *When considering resource consents for activities in wetlands, recognise:*
>
> 1) *the benefits of wetland creation and restoration, and the enhancement of wetland functions, and*
>
> 2) *that the values of induced wetlands or reverted wetlands are likely to relate to:*
>
> a) *the length of time the wetland has been in existence (ecological values are generally lower in newly established wetlands), and*
>
> b) *whether long-term viability of the wetland relies on maintenance works to maintain suitable hydrological conditions (wetlands that do not require maintenance are of greater value), and*
>
> 3) *that the consent duration should be for as long as active restoration or enhancement works are required.*

The Offset and Compensation Plan will involve the restoration and enhancement of natural wetland outside of the reservoir footprint.

Policy D.4.24 directs decision-makers to recognise:

> 1) *that in the absence of alternative evidence, most Northland continually or intermittently flowing rivers and some lakes and natural wetlands provide habitat for Threatened or At Risk indigenous fish species, and*
>
> 2) *that all fish species have varying degrees of sensitivity to habitat disturbance, changed water flow and degraded water quality, particularly increased turbidity or sedimentation, and*
>
> 3) *the need to maintain the ability for non-pest fish species to effectively move up and downstream of the activity site, and*
>
> 4) *opportunities to reduce the risk of spreading or introducing pest species, and*
>
> 5) *the benefits of avoiding:*

> a) *activities in continually or intermittently flowing rivers during fish migration periods, and*
>
> b) *spawning habitat disturbance, particularity during spawning periods.*

It is important to note that the first clause of Policy D.4.24 effectively states that all of Northland's continually and intermittently flowing rivers are significant habitats of indigenous fauna – as per Policy D.2.16(1)(a)(ii).

The streams flowing through the reservoir footprint are significant habitats of indigenous fauna because longfin eel have been found in them. Fish passage for eels over the reservoir embankment will be provided. The fish passage however will prevent the upstream movement of any introduced pest fish species. The Freshwater Fauna and Salvage Plan will assist with avoiding and minimising adverse effects native freshwater fish species.

6.5.5 Natural Character, Features, Landscapes

Objective F.1.1 is also like Objective 3.14 of the RPS about natural character, outstanding natural features and historic heritage. The objective, which is subject of an appeal to the Environment Court, is:

> *Protect from inappropriate use and development:*
>
> 3) *the characteristics, qualities and values that make up:*
>
> …
>
> c) *natural character in freshwater bodies outside the coastal environment…*

Policy D.2.15 also provide similar direction to the RPS. It states that the adverse effects of activities on natural character of freshwater bodies and their margins outside of the coastal environment must be managed by avoiding significant adverse effects on the characteristics, qualities and values that contribute to natural character. The policy also recognises:

> 4) *…that in relation to natural character in waterbodies (where not identified as outstanding natural character), appropriate methods of avoiding remedying or mitigating adverse effects may include:*
>
> a) *ensuring the location, intensity, scale and form of activities is appropriate having regard to natural elements and processes, and*
>
> …
>
> c) *in freshwater, minimising to the extent practicable modification (disturbance, structures, extraction of water and discharge of contaminants) …*

The assessment of the activity against Policy 4.6.1 of the RPS satisfies the required assessment against Policy D.2.15 of the PRP.

6.5.6 Resource Consent Duration

Section 123 of the RMA defines the period for which consents may be granted. Under section 123(b) the period for which any land use consent is granted is unlimited unless otherwise specified in the consent or if it for an activity that would contravene section 13 of the RMA. Section 123 goes on to set an upper limit of 35 years for discharge and water permits but section 123(d) limits discharge and water permits to five years unless an alternative duration is specified in the consent.

Policy D.2.12, which is the subject of appeals to the Environment Court, provides direction on resource consent duration:

> *When determining the expiry date for a resource consent, have particular regard to:*
>
> 1) *security of tenure for investment (the larger the investment, then generally the longer the consent duration), and*

2) *the administrative benefits of aligning the expiry date with other resource consents for the same activity in the surrounding area or catchment, and*

3) *certainty of effects (the less certain the effects, the shorter the consent duration), and*

4) *whether the activity is associated with regionally significant infrastructure (generally longer consent durations for regionally significant infrastructure), and*

5) *the following additional matters where the resource consent application is to re-consent an activity:*

    a) *the applicant's past compliance with the conditions of any previous resource consent or relevant industry guidelines or codes of practice (significant previous non-compliance should generally result in a shorter duration), and*

    b) *the applicant's voluntary adoption of good management practice (the adoption of good management practices that minimise adverse environmental effects could result in a longer consent duration).*

Having considered the policy, Te Tai Tokerau Water Trust considers that the resource consents for which it has applied should be for the periods set out in **Table 17**.

Table 17. Proposed consent durations.

Land use consents		
Activity	**RMA**	**Duration**
• Erect a dam structure in, on, under, and under the bed of a Te Ruatehauhau Stream[16] • Disturb the bed of Te Ruatehauhau and Waitaia Streams • Deposit a substance in, or, and under the bed of Te Ruatehauhau Stream • Reclaim the bed of Te Ruatehauhau Stream	Section 13	10 years
Water permits		
Activity	**RMA**	**Duration**
• Temporarily divert Te Ruaotehauhau Stream during construction	Section 14	10 years
• Divert and dam freshwater behind the proposed reservoir embankment when catchment inflows exceed the median flows • Divert and dam available 'core allocation' freshwater behind the proposed reservoir embankment outside the irrigation season (May – October) • Divert freshwater through the proposed embankment • Divert freshwater around the proposed embankment (via spillway) • Take and use dammed water	Section 14	35 years
Discharge permits		
Activity	**RMA**	**Duration**
• Discharge stormwater to water associated with land disturbance activities	Section 15	10 years
• Discharge groundwater from dewatering activities to water	Section 15	10 years

6.5.7 Other

The PRP contains several other relevant provisions.

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[16] Once the embankment is constructed its presence is a permitted activity as it has been lawfully established.

Objective F.1.4 is that “Northland’s natural and physical resources are managed in a way that is attractive for business and investment that will improve the economic well-being of Northland and its communities.” Objective F.1.10 is to “[e]nable and positively recognise activities that contribute to improving Northland's natural and physical resources. Granting consents to authorise the proposal will achieve the objective.

Policy D.2.2 is that “[r]egard must be had to the social, cultural and economic benefits of a proposed activity, recognising significant benefits to local communities, Māori and the region including local employment and enhancing Māori development, particularly in areas of Northland where alternative opportunities are limited.”

The policy goes to the nub of the issue that prompted the NSWUP – there is a desperate need sustainable and enduring projects that will recognise significant social, economic and cultural benefits to people and communities in Northland, particularly Māori because of the constraints around developing Māori Freehold Land.

Policy D.4.25 is about the benefits of freshwater structures, dams and diversions:

> *Recognise the significant benefits activities in water bodies can provide to local communities, Māori and the region, including:*
>
> 1) *socio-economic well-being and resilience of communities or industry, and*
> 2) *regionally significant infrastructure, and*
> 3) *enhanced fish passage and ecological connectivity between the coastal marine area and the upstream extent of water bodies, and*
> 4) *flood protection and the safeguarding of public health and safety, and*
> 5) *public access along, over or in the water body, and*
> 6) *enabling community resilience to climate change, and*
> 7) *enhancing recreation opportunities including walking, bird watching, fishing, game bird hunting and boating, and*
> 8) *education and scientific research, and*
> 9) *enhancing amenity and natural character.*

The proposal is expected to deliver the benefits identified in the first, fourth and sixth clauses of the policy.

6.6 Regional Water and Soil Plan for Northland 2007 (updated 2014)

The PRP will replace the RWSP, and because it has progressed through to the appeals process it is appropriate to put more emphasis on it.

The focus here is on provisions that are not reflected in the PRP but are directly relevant to the proposal. They are about managing activities in the beds of river

Objective 11.4.4 is:

> *The management, control of location and frequency of structures in, on, under or over the beds of rivers and lakes so as to maintain adequate minimum continuation flows in order to provide for:*
>
> *(a) The protection of indigenous aquatic ecosystems and habitats;*
>
> *(b) The current and potential needs of existing lawful water users;*

> *(c) The need to manage potential risk upon property and people; and*
>
> *(d) The maintenance of natural character.*

Continuation flows will be provided through the embankment of the proposed reservoir to maintain the health of downstream aquatic ecosystems, habitats and species and ensure that existing authorised takes are not adversely affected.

Objective 11.4.5 is “the provision of fish and invertebrate passage for indigenous fish and invertebrate species and trout, within rivers, lakes and indigenous wetlands is sufficient to sustain viable fish and invertebrate populations.”

The reservoir embankment will be designed to incorporate fish passage for eels. The reservoir will support viable invertebrate populations.

Objective 11.4.6 is “the use of off-stream reservoirs and other off-stream water storage techniques as an alternative to the placement of dam structures on the beds of rivers and lakes.”

While an off-stream water storage system is desirable from an ecological perspective, a system is not practicable for the Mid-North Water Scheme. Constructing a 1.4M m^3 reservoir requires a valley formation for it to be economically viable.

Policy 11.5.13 is:

> *When considering consents for constructing new dam structures on the bed of a river or lake to require:*
>
> *(a) In permanently flowing rivers the maintenance of design minimum flows sufficient to meet the needs of existing aquatic ecosystems;*
>
> *(b) That the migration of indigenous fish and invertebrate species, and trout is provided for in accordance with Policies 11.05.15 and 11.05.16;*
>
> *(c) Dissolved oxygen, water temperature and other chemical thresholds that are critical to indigenous aquatic life and healthy ecosystem functioning are maintained;*
>
> *(d) Current and potential future land uses are considered;*
>
> *(e) The proximity of dwellings, public land and areas where the public reside or congregate are taken into consideration with regards to the potential risks and hazards;*
>
> *(f) Adverse effects on significant indigenous vegetation and significant habitats of indigenous fauna are avoided, remedied or mitigated;*
>
> *(g) Potential adverse effects on existing lawful water users are avoided, remedied or mitigated.*

Policy 11.5.14 is “to control the location, size, scale and frequency of dam structures within rivers and lakes to ensure that adequate continuation flows are maintained within the catchment.”

Policy 11.5.15 is “depending on actual or potential upstream existence of habitat for indigenous fish or invertebrate species or trout, the construction and maintenance of fish and invertebrate passes for new dam structures on the beds of rivers or lakes is required, except where no flow beyond the structure is required.”

This application addresses the requirements of Policies 11.5.13, 11.5.14, and 11.5.15.

6.7 Far North District Plan

6.7.1 Rural Production Zone

The objectives in Chapter 8.6 of the FNDP reflect the purpose of the Act and the purpose of the zone, i.e., enabling farming and activities and activities ancillary to rural production whilst maintaining and enhancing amenity values associated with the rural environment, and at minimising the likelihood and risk of incompatible land uses establishing in proximity to each other.

It is considered that the proposed Te Ruaotehauhau Water Storage Reservoir will meet the objectives for the Rural Production Zone.

While the proposed reservoir is not a farming or rural production activity, per se, it will support and promote horticultural activities through the efficient use and development of high value soils in the area. The proposed reservoir will not give rise to reverse sensitivity effects because it will be in keeping with the landscape and amenity values of the rural environment.

In these respects, the proposal is consistent with relevant Policies 8.6.4.1, 8.6.4.3, 8.6.4.4, 8.6.4.5, and 8.6.4.7.

6.7.2 Natural and Physical Resources

The proposal includes clearing indigenous vegetation. The FNDP contains objectives and policies for recognising and protecting ecological values. The objectives in Chapter 12.2 also consistent with the purpose of the Act, section 6(c) of the Act, and Objective 3.4 of the RPS, and therefore have not been reproduced here.

It is important to note that the FNDP predates the RPS and therefore it is considered that weight should be had to the relevant provisions in the RPS (refer **Section 6.2**) regarding indigenous ecosystems and biodiversity, and active management and enhancement. This is consistent with case law on the matter. Importantly, the RPS specifies a different approach to identifying and protecting areas of significant indigenous vegetation and significant habitats of indigenous fauna.[17]

Relevant objectives and policies in the RPS are assessed in **Section 6.4.3**, above, with respect to the proposal to clear indigenous vegetation in the footprint of the proposed reservoir.

Chapter 12.3 of the FNDP contains objectives and policies on maintaining the life-supporting capacity of soils and managing adverse effects arising from soil excavation and filling, and mineral extraction.

Significant earthworks activities will be required to construct the proposed reservoir. It is expected that approximately 300,000m^3 of earth will be cut and filled. Best practice erosion and sediment control measures will be implemented through the duration of the earthworks activities and will remain in place until the site is stabilised. It is proposed that a CMP, including an ESCP, are prepared and implemented in accordance with conditions of the sought resource consents. It is considered that the proposal, undertaken in accordance with the CMP, will have no more than minor effects to the environment or human health.

The proposed reservoir will help safeguard the life-supporting capacity of soil through the conversion of pasture on productive soils to higher value horticultural enterprises.

The cultural, spiritual and heritage values of the site of the proposed reservoir are highly valued. An application for a general archaeological authority to modify a recorded archaeological site is being lodged with Heritage New Zealand Pouhere Taonga, and local whanau and hapu have been actively involved in discussions and investigations regarding the site. While it is not practicable to avoid modifying all aspects of the archaeological site, an archaeological management plan and research strategy will be developed and implemented to manage potential effects and guide the investigation of archaeological features as mitigation for those effects. The applicant will also undertake consultation with Tangata Whenua in light of the findings and recommendations

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[17] Policy 12.2.4.2 of the FNDP states that the significance of areas of indigenous vegetation are to be evaluated against the criteria in Appendix III of the Northland Regional Policy Statement. That policy statement has been repealed and replaced with the RPS 2016.

from this report, as part of the archaeological authority process and should develop protocols around the appropriate tikanga for Māori archaeological sites and features and discuss opportunities for cultural monitoring of earthworks. Areas of stone mounds and associated archaeological features outside of the reservoir footprint will be identified for possible permanent protection through heritage covenants.

Therefore, it is considered that the proposal is consistent with relevant Policies 12.3.4.1, 12.3.4.2, 12.3.4.3, 12.3.4.4, and 12.3.4.5.

6.8 Assessment Summary

The economic and social benefits arising from the proposal are well-documented. The potential productive uses that may result from a resilient and efficient source of water supply as proposed are profound and extensive, and therefore the objectives and policies that support economic and social well-being can be met.

It is considered that the proposal to construct and operate Te Ruaotehauhau Water Storage Reservoir is not contrary to any objectives or policies of the PRP and RWSP.

7. Assessment of Environmental Effects

Clause 2(3) of Schedule 4 of the RMA states:

> *An application must also include an assessment of the activity's effects on the environment that—*
>
> *(a) includes the information required by clause 6; and*
>
> *(b) addresses the matters specified in clause 7; and*
>
> *(c) includes such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.*

The information requirements in clause 6 are addressed in **Table 18** below.

Table 18. Information requirements in clause 6(1).

Information requirement	Comment
(a) if it is likely that the activity will result in any significant adverse effect on the environment, a description of any possible alternative locations or methods for undertaking the activity:	It is considered that the proposal will not result in any significant adverse effects on the environment if the proposed conditions of consent are adopted and implemented.
(b) an assessment of the actual or potential effects on the environment:	The following section of this application contains an assessment of actual and potential effects on the environment.
(c) if the activity includes the use of hazardous installations, an assessment of any risks to the environment that are likely to arise from such use:	The term "hazardous installation" is not defined in the RMA or otherwise used in the RMA. It is assumed here that the proposed reservoir will be a hazardous installation because there is the risk of people and property being adversely affected if the dam would fail. The potential impact classification is set out in RILEY's report at **Appendix E** of this application. It is particularly important to note that potential impact classifications are independent of the likelihood failure, which, for a suitably designed, constructed and operated dam, should be very low. Detailed dam designs have yet to be completed but will be required to obtain a building consent to authorise the construction of the proposed reservoir.
(d) if the activity includes the discharge of any contaminant, a description of— *(i) the nature of the discharge and the sensitivity of the receiving environment to adverse effects; and* *(ii) any possible alternative methods of discharge, including discharge into any other receiving environment:*	Discharges of stormwater, including sediment, are expected during the construction of the reservoir. However, best practice erosion and sediment control measures will be implemented before and throughout the duration of the activity and will be removed once the site is fully stabilised. Discharges of water from the proposed reservoir (via a constructed spillway) will happen periodically. More information that is required by clause 6(1)(b) of Schedule 4 of the RMA is provided in this section.
(e) a description of the mitigation measures (including safeguards and contingency plans where relevant) to be undertaken to help prevent or reduce the actual or potential effect:	A description of the mitigation measures reflected in the proposed conditions of resource consent (refer **Appendix J**).
(f) identification of persons who may be affected by the activity and any response to the views of any persons consulted, including the views of iwi or hapū that have been consulted in relation to the proposal:	See **Section 8** of this application.
(g) if the scale and significance of the activity's effects are such that monitoring is required, a description of how the effects will be monitored and by whom, if the activity is approved:	See **Section 9** of this application.

Information requirement	Comment
(h) If the activity will, or is likely to, have adverse effects that are more than minor on the exercise of a protected customary right, a description of possible alternative locations or methods for the exercise of the activity (unless written approval for the activity is given by the protected customary rights group).	No customary rights will be affected by the proposal.

Clause 7(1) of Schedule 4 of the RMA states:

> *An assessment of the activity's effects on the environment must address the following matters:*
>
> *(a) any effect on those in the neighbourhood and, where relevant, the wider community, including any social, economic, or cultural effects:*
>
> *(b) any physical effect on the locality, including any landscape and visual effects:*
>
> *(c) any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity:*
>
> *(d) any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural value, or other special value, for present or future generations:*
>
> *(e) any discharge of contaminants into the environment, including any unreasonable emission of noise, and options for the treatment and disposal of contaminants:*
>
> *(f) any risk to the neighbourhood, the wider community, or the environment through natural hazards or hazardous installations.*

The matters are addressed below.

7.1 Effects on the Neighbourhood and Wider Community

7.1.1 Enabling Social and Economic Wellbeing

Northland is a regional economy that underperforms relative to most other regions of New Zealand despite its resource base. The way natural and physical resources (including infrastructure) are managed, particularly through regulation, is important to the economy. It directly affects how markets, and individuals and businesses in those markets, operate and allocate their resources. Availability and security of water is fundamental to productive land use for food production and potable water supply for the health and well-being of the people and communities, particularly with a changing climate.

The purpose of proposed Te Ruaotehauhau Water Storage Reservoir is primarily, along with other components of the Mid-North Water Scheme, to change pastoral land use to higher value horticultural land use, while avoiding increases in livestock intensification. It is expected that Te Ruaotehauhau Water Storage Reservoir will be able to support approximately 390 hectares of horticulture development.

The development of the proposed reservoir and other components of the Scheme will result in intergenerational benefits for the Mid-North area. The findings from the prefeasibility phase confirm that there are substantial economic benefits to be realised through the development of the Mid-North Scheme. The benefits will come from a substantial lift in horticultural production and flow-on effects to other sectors. It is expected that for every $1 million invested on building the Scheme, there will be an on-going annual lift in economic activity (as measured by GDP) of $1.3 million and a rise in economic well-being (measured by household income) of $0.6 million per year.

A key focus of the NWSUP has been to deliver opportunities for Māori landowners to develop their land through the delivery of reliable water. There is considerable Māori Freehold Land around Kaikohe that could be developed for horticulture if a sufficient, reliable water source is available.

Table 19. Māori Freehold Land and population within the Mid-North Command area.

Variable	Command Area
Māori Freehold Land (ha)	1,000
Māori Freehold Land (% command area)	17%
Māori population (total)	5,232
Māori population (% total population)	71%

7.1.2 Life-Supporting Capacity of Soil Resource

The proposed development will have a positive impact on the life supporting capacity of the soil on the properties which it will service. It will enable more sustainable and higher value farming operations on soils currently under pasture but better suited to horticulture.

It is considered that the benefit of preserving the land in the reservoir footprint for pastoral farming is far outweighed by using it for storing water for safeguarding and enhancing the life-supporting capacity of horticultural soils in the command area.

7.1.3 Effects on Tangata Whenua Values and Interests

The Resource Management Unit for the Taiāmai ki e Takutai Moana is preparing a cultural impact assessment of behalf of ngā hapū. It will also be prepared on behalf of Te-Rūnanga-ā-Iwi-o-Ngāpuhi. The assessment had not been finalised at the time this application was lodged, but it is understood that it will be available prior to the deadline for the consent authority to make a decision on this application.

7.1.4 Effects on Existing Authorised Takes

It is understood that there are two consented surface water takes downstream of the proposed reservoir (AUT.071199.01.02 and AUT.028688.01.02). The purpose of the consents is listed as “to take water for pasture irrigation”. There are no other downstream consented surface water takes until the lower reaches of the Waitangi River. It is expected that there are downstream permitted takes (by section 14(3)(b) of the RMA and regional rules.

Appendix C contains a WWLA’s report on the hydrological analysis of the Te Ruaotehauhau Creek and the effects on downstream water users because of the reservoir. Regarding the impact of the proposed ‘core allocation’ take, Mawer (2020) states:

> *The proposed core allocation take for direct inflows to the reservoir will only occur during winter. As the downstream consented takes … are for irrigation of pasture, the consents would only be utilised during summer. Therefore, it is considered there will be no effect on downstream consented water takes associated with a winter core allocation take for direct inflows to [Te Ruaotehauhau Water Storage Reservoir].*

Regarding the impact of the proposed ‘high flow take’, WWLA (**Appendix F**) states:

> *The harvesting of high flows will not negatively affect the downstream consented water take. The reservoir high flow take will only occur during times of above median flow at the reservoir (> 29 L/s), and therefore, there will be at least 23.6 L/s in excess of the consented take rate passing downstream of the reservoir during periods of high flow harvesting. In addition, the consented irrigation take is not likely to be operational during times of high-flow taking (i.e. wet periods). Consistent with the findings of the report, it is consistent that any adverse effects on authorised downstream takes will be no more than minor.*

> *In terms of takes permitted under a Regional Plan or by Section 14(3)(b) of the Resource Management Act 1991, total daily take per property downstream of the lowest point of proposed taking is estimated at:*
>
> *a) 10 cubic meters (equivalent to 0.116 L/s), or*
>
> *b) 30 cubic metres (equivalent to 0.347 L/s) for the purposes of dairy shed wash down and milk cooling water.*
>
> *Flows below the median (up to 28 L/s) will not be harvested and will bypass the reservoir. Therefore, significant water remains available for permitted takes during periods of high flow harvesting. The median flow of 29 L/s at the location immediately downstream of TRSWSR embankment is equivalent to 250 permitted takes at 0.116 L/s, or 83 permitted takes at 0.347 L/s. In addition, catchment flow increases with increasing distance downstream as additional lateral inflows occur and tributaries join.*
>
> *Based on the above, the potential negative impacts on downstream water users are considered to be no more than minor.*

7.2 Physical Effects, Including Landscape and Visual Effects

Simon Cocker Landscape Architecture undertook a comprehensive landscape and visual amenity assessment (refer **Appendix G**). The landscape and visual amenity assessment report concludes:

> *The proposal includes a landscape and visual mitigation concept which, it is proposed be developed as a condition of consent in conjunction with the project ecologist.*
>
> *The assessment has determined that the potential adverse landscape effect of the proposal will be moderate locally, once the mitigation measures are completed, and low when considered in the context of the wider environment, again, once the mitigation or offset measures have been implemented.*
>
> *The level of potential adverse visual effect is assessed as being high for the occupants of 5 dwellings, moderate to high for the occupants of 1 dwelling and moderate for the occupants of 2 dwellings. The balance of potentially affected individuals, including users of Hariru Road, will be affected to a low level.*

The report makes several recommendations to mitigate the potential adverse effects on landscape and visual amenity values, including:

- Shaping and revegetating the final landform so that it integrates with the adjoining unmodified land.
- Grading the downstream downslope of the left-hand embankment so that it has a gentler gradient.
- That a landscape mitigation and management plan be required as a condition of resource consent, which will bed developed with local landowners and person(s) responsible for developing ecological management plans.

The applicant supports the recommendations.

The landscape and visual amenity report concludes that “the proposal is considered to be consistent with the objectives and policies of the various statutory instruments where they are of relevance to this assessment.”

Geometria Ltd undertook an archaeological assessment of the site and adjacent area (refer **Section 4.3.3**). Some archaeological features were recorded but are outside of the reservoir footprint. They will not be affected by the construction of the proposed reservoir. In short, the archaeological assessment report states that the effects of the construction of the proposed reservoir on the recorded archaeological site (P05/1091) are high. It also states:

> *The proposed new reservoir will affect an archaeological landscape, comprising approximately 10ha of proto and or pre-historic Maori horticultural features. Artefacts, cultivable taro, obsidian artefacts, and historic stone walls are found in association with the horticultural system which comprises low stone mounds and shallow trenches. These features were previously unrecorded, and have now been added to the New Zealand Archaeological Association database ArchSite as P05/1091.*

> *While not locally or regionally rare, these features are in good condition and are associated with a highly significant historic and cultural landscape. The site has been assessed as being of moderate archaeological significance overall.*
>
> *The Te Ruaotehauhau Water Reservoir will destroy approximately 7000m^2 of these features, with additional effects on 3ha due to modification by inundation within the reservoir footprint. There will likely be additional effects on subsurface archaeological features, and effects from haul roads, borrow areas, yards and hard stands, and the development of wetlands and areas in native planting to offset those affected by the reservoir. There are also likely to be downstream effects from developing pipe services to supply water from the reservoir, and land use change/intensification from horticultural development.*

The archaeological assessment report makes eight recommendations, which are supported by the applicant, including applying for a general archaeological authority under the Heritage New Zealand Pouhere Taonga Act 2014 to modify recorded archaeological site P05/1091 and developing an archaeological management plan and research strategy to manage archaeological effects from the project. Some of the recommendations will avoid or mitigate adverse effects on archaeological features.

7.3 Effects on Ecosystems

Puhoi Stour in association with Tonkin & Taylor undertook a comprehensive assessment of ecological effects associated with the construction of the proposed reservoir (refer **Appendix F**). A summary of Wong, et al (2020) findings and recommendations are set out in this section.

7.3.1 Aquatic Ecology

The ecological assessment report (**Appendix F**) identified six categories of actual and potential adverse effects of the construction and operation of the proposed reservoir on aquatic ecology:

- Sedimentation during construction.
- Injury or mortality of freshwater fauna.
- Impediment to fish passage.
- Permanent modification of stream habitat.
- Downstream water quality effects.
- Downstream habitat effects

7.3.1.1 Sedimentation During Construction

The construction of the proposed reservoir has the potential to result in a temporary increase in sediment losses to water. It is well recognised that elevated levels of suspended and deposited sediment can adversely affect aquatic ecosystems.

The ecological assessment report recommends that any streamworks are done during the earthworks season and in accordance with best practice (i.e., Auckland Council Guidance Document 5). They consider that “with the appropriate construction and sediment and erosion control methodologies to mitigate sediment and erosion control effects, the magnitude of effects could be reduced to low, and so the overall level of effects could be reduced to a low level.”

It is proposed that an ESCP, part of a CMP, is required as a condition of resource consent (**Appendix J**).

7.3.1.2 Injury or Mortality of Freshwater Fauna

Constructing the proposed reservoir could result in injury to or the death of native freshwater fauna during mechanical modification of waterbodies within the reservoir footprint. Wong, et al. (2020) recommend that a Freshwater Fauna Relocation Plan should be prepared as part of the reservoir construction methodology to minimise injury or mortality or freshwater fauna during streamworks and reservoir filling. They consider that with appropriate salvage and relocation methods, as detailed in a FFRP, the magnitude of adverse effects on fish during construction and reservoir filling, could be reduced to low and the overall level of effects to low.

It is proposed that a Freshwater Fauna Relocation Plan be required as a condition of resource consent (**Appendix J**).

7.3.1.3 Fish Passage

The placement of structures in streams and rivers can restrict the movement of fish, this is particularly relevant for dams. The ecological assessment report recommends the provision of fish passage for eels (upstream and downstream) into the proposed reservoir. They consider that an elver pass could be constructed up and over the face of the dam, however if that is not feasible then a trap and haul programme should be established to populate the reservoir with elvers. They also recommend consideration for downstream movement of migrant eels should be included in the spillway design.

With respect to eel passage, the ecological assessment report states that the magnitude of the effect caused by impeding fish passage is moderate and the overall effect is high. However, it recommends that the dam design provides for eel passage and the applicant provides a compensation package to restore stream habitat outside of the proposed reservoir

It is proposed that eel passage is required as a condition of resource consent (**Appendix J**).

7.3.1.4 Permanent Modification of Stream Habitat

The proposed reservoir will inundate approximately 2,114 m (or approximately 5,285 m^2 of streambed area) of continually flowing streams and approximately 538 m (or approximately 108 m^2 of streambed area) of intermittently flowing stream.

The overall level of effects from the permanent loss of stream habitat is very high. The ecological assessment report recommends restoration of existing streams outside of the footprint of the proposed reservoir to offset the effects of the reservoir. They used an Environmental Compensation Ration (ECR) tool to determine that approximately 12,671 m^2 and 725 m^2 (collectively 13,305 m^2) of similar permanent and intermittent streambed area habitat enhancement in nearby catchments in Kaikohe is required to achieve no net loss of ecological function.

It is proposed that a Offset and Compensation Plan is required as a condition of resource consent (**Appendix J**). The Plan will identify, among other things, the location(s) of proposed riparian planting, plant species and sizes, spacing and weed maintenance.

7.3.1.5 Downstream Water Quality Effects

Reservoirs have the potential to impact on downstream water quality, particularly as a result of changes in water temperature. The reservoir outlet will be situated close to the base of the reservoir, and therefore water at the outflow will not be affected by solar and thermal radiation. The ecological assessment report states that the magnitude of the potential impact of the reservoir on water quality to be low and as such the overall level of effect is low.

7.3.1.6 Downstream Habitat Effects

Dams affect the downstream transport for coarse and fine sediment, which has the potential to impact physical instream habitat. They also modify downstream flow regimes.

The ecological assessment report states that the magnitude and impact of the proposed reservoir on downstream habitat is likely to be low.

WWLA undertook an assessment of the proposed reservoir on downstream flows (refer **Appendix C**).[18] The hydrology assessment (**Appendix D**) found that the largest impact on stream flow in Te Ruaotehauhau is directly downstream of the proposed reservoir due to the damming of flows above the median flow. The report also found that because flows below the median flow are bypassed, there is no change in streamflow 50% of the time. The hydrological impacts of the proposed reservoir decrease relatively quickly downstream of the reservoir.

The hydrology report also concludes that the proposed reservoir may cause a small, localised increase in groundwater levels due to reservoir seepage, which is considered to be beneficial because of increased streamflows.

7.3.2 Terrestrial Ecology

7.3.2.1 Vegetation Effects

Constructing the reservoir will involve removing vegetation within its footprint. The ecological assessment report quantified that the total quantity of indigenous vegetation to be cleared is 1.46 ha, with an additional 0.75 ha of volcanic boulderfield, 1.32 ha of exotic forest and 0.22 ha of wet pasture. Specifically:

- 0.47 ha of pūriri forest;
- 0.32 ha of swamp forest;
- 0.44 ha of secondary broadleaf forest with old-growth signatures;
- 0.14 ha of tōtara treeland;
- 0.75 ha of volcanic boulderfield;
- 0.03 ha of rautahi wetland;
- 0.05 ha of kutakuta wetland;
- 1.32 ha of exotic forest; and
- 0.22 ha of wet pasture.

The report contains a prediction on the magnitude of effect of the proposal on each affected ecosystem type and threatened and at-risk flora and fauna. The report also determines the overall level of ecological effect by combining the magnitude of effect with the ecological value of the ecological characteristic. The findings are summarised in **Table 20**.

Table 20. Magnitude and overall level of effect on terrestrial vegetation habitat without mitigation measures (including offsetting and compensation measures)

Vegetation type	Magnitude of effect	Ecological Value	Overall effect
Pūriri forest	Moderate	Very high	High
Swamp forest	Moderate	Very high	High
Secondary broadleaf forest	Moderate	Moderate	Moderate
Tōtara treeland	Moderate	Moderate	Moderate
Volcanic boulderfield	Moderate	High	High
Exotic pine forest	Moderate	Moderate	Moderate
Rautahi wetland	Low	High	Low
Kutakuta wetland	Low	High	Low
Swamp maire	High	Very high	Very high
Kānuka, rātā vines a	Low	Very high	Moderate

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[18] WWLA, September 2020. Consenting for K-13 Reservoir: Hydrology Assessment. Prepared by Williamson Water & Land Advisory. Project No: WWLA0239.

Vegetation type	Magnitude of effect	Ecological Value	Overall effect
Mānuka	Low	High	Low
Wet pasture	Low	Low	Low

The ecological assessment of effects report states that without mitigation, the clearance of the vegetation will result in a loss of habitat for indigenous fauna, potential mortality of indigenous fauna, and increased fragmentation, and the loss of wetland and indigenous plant species. However, they consider that the overall level of adverse ecological effects can be offset and compensated as per the recommendations set out in their report. The report states that the implementing the mitigation, offset and compensation measures will ensure 'No Net Loss' of vegetation values (refer **Appendix F**).

It is proposed that an Offset and Compensation Plan (to address both freshwater and terrestrial residual effects) be required as a condition of resource consent.

7.3.2.2 Fauna Effects

Without mitigation the ecological assessment of effects report states that the removal of vegetation can result in the injury or mortality of birds, bats, lizards and invertebrates.

Table 21. Magnitude and overall level of effect on indigenous fauna without mitigation measures (including offsetting and compensation measures)

Fauna	Magnitude of effect	Ecological Value	Overall effect
Native bats	High	Very high	Very high
Forest birds – miromiro and kukupa	Moderate	High	High
Forest birds - tūī	Moderate	Moderate	Moderate
Other common forest birds	Low	Moderate	Low
North Island brown kiwi	High	High	Very high
Pitpit	Moderate	High	High
Native lizards – forest gecko, elegant gecko, Northland green gecko, and ornate skink	High	High	Very high
Native lizards – Pacific gecko	High	Moderate	Moderate
Kauri snail habitat	Moderate	High	High

The report recommends the following fauna management plans be developed and implemented to prior to reservoir construction:

- Bat Management Plan (BMP).
- Avifuana Management Plan (AMP).
- Lizard Management Plan (LMP).
- Invertebrate Management Plan (IMP).

It is proposed that the management plans be required as a condition of resource consent.

7.3.3 Summary of effects

The ecological assessment of effects report concludes:

> *If the ... management recommendations are implemented in full, and subject to further site visits to confirm potential offset and compensation areas, it is considered that effects to terrestrial and wetland ecosystems*

> *can be mitigated, offset and compensated for sufficiently, primarily through wetland planting and enhancement, and fauna management plans. Similarly, effects on freshwater ecosystems and fauna can be mitigated through implementation of management plans and residual adverse effects addressed through offset or compensation measures on similar habitats in the wider catchment.*

Table 22, reproduced from tables 10 and 11, of the ecological assessment of effects report summarises the magnitude of effects before without mitigation measures and the resulting level of effect if management measures are implemented in full.

Table 22. Summary of level of effects (before and after mitigation) on ecological values associated with each activity.

Effect	**Level of effect (prior to management measures)**	**Overall level of effect (if management measures implemented in full)**	**Comment**
Aquatic ecology			
Sedimentation effects from construction activities	High	Low	Earthworks will be undertaken during the earthworks season and be done in accordance with an ESCP.
Injury or mortality to aquatic fauna	High	Low	A FFRP will be prepared and implemented.
Impediments to fish passage	Moderate	Low	Fish passage for eels will be provided.
Permanent modification and loss of stream habitat	Very high	Very high (can be offset)	An Offset and Compensation Plan will be prepared and implemented.
Impacts on water quality and habitat downstream of the proposed dam	Low	Low	The proposed reservoir will be constructed with an outlet towards the base and will be operated in accordance with an ORMP.
Terrestrial ecology (including avifuana)			
Removal of threatened trees and vegetation	Low to very high	Low to very high (can be offset and compensated)	An Offset and Compensation Plan will be prepared and implemented.
Long-tailed bat	Very high	Low	A BMP will include vegetation removal protocols (including seasonal clearance constraints) which will avoid impacts to potentially roosting bats. Theresults of acoustic monitoring will also guide appropriate measures to address the loss of potential roost, foraging and commuting habitat if required.
Tūī	Moderate	Low	Offset and compensation plantings will provide additional habitat. An AMP will involve seasonal clearance constraints and bird nest checks, further reducing the magnitude of effect by avoiding disturbance and mortality impact to nesting birds, chicks and eggs.
Kukupa, miromiro	High	Low	
Other Not Threatened avifauna	Very low	Very low	
North Island brown kiwi	Very High	Low	An AMP will detail kiwi monitoring and management protocols. Kiwi monitoring will determine possible kiwi presence after which appropriate management can be applied.

Effect	Level of effect (prior to management measures)	Overall level of effect (if management measures implemented in full)	Comment
New Zealand pipit	High	Low	Seasonal clearance constraints and bird nest checks as outlined in an AMP.
Herpetofauna	High	Low	An LMP will include seasonal vegetation clearance and salvaging protocols. Salvaging protocols will include construction-assisted habitat searches and gecko spotlighting.
Forest gecko, elegant gecko, Northland green gecko and ornate skink	High	Low	Lizard salvaging and relocation as detailed in a LMP.
Pacific gecko	Moderate	Low	
Copper skink	Low	Very low	
Kauri snail	High	Low	Implementation of an IMP will include snail searching and salvaging prior to vegetation clearance.

7.3.4 Ecological Benefits

There are environmental benefits to developing a water storage scheme given an increased focus on environmental enhancement opportunities such as riparian planting and development and enhancement of wetlands post construction to be implemented by way of an Ecological Offsetting and Compensation Plan.

It is expected that the proposed reservoir will provide same and similar functions wetlands, including buffering storm flows, reducing water temperature, and providing habitat for eels. Revegetated surrounding margins and adjoining gullies will provide habitat to indigenous fauna and flora.

The conversation of land used for pastoral farming to horticulture is likely to result in a reduction of sediment and faecal pathogen losses to water. The availability and reliability of water supply is needed to support such land use change.

7.4 Effects on Natural and Physical Resources Having Other Special Values

Clause 7(1)(d) of Schedule 4 of the RMA requires an assessment of environmental effects to address any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural value, or other special value, for present or future generations.

7.4.1 Recreational Values

There are no known recreational values associated with the unnamed tributaries of the Te Ruaotehauhau Stream within and downstream of the proposed reservoir.

7.4.2 Historical Values

Geometria Ltd undertook a detailed archaeological assessment of the site of the proposed Te Ruaotehauhau Water Storage Reservoir (**Appendix H**).[19] The archaeological assessment includes an overview of the historic background of the location of the proposed reservoir and the broader area within which it is to be located.

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[19] Geometria Ltd, 24 August 2020. Archaeological Assessment of the Proposed Te Ruaotehauhau Water Storage Reservoir. Prepared for Te Tai Tokerau Water Trust. Geometria Ltd. Reference: 2020-128.

A summary of the key archaeological findings are documented elsewhere in this application. It suffices to say that the site of the proposed reservoir and the surrounding area has rich cultural and historical heritage

7.4.3 Cultural and Spiritual Values

A Māori cultural impact assessment is being prepared. While it was not completed when this application was lodged, it is expected to be available to the consent authority before it is required to make a decision on this application.

7.5 Discharge of Contaminants and Emission of Noise

7.5.1 Construction Noise, Dust, and Traffic Effects

During construction, there will be potential for noise, dust nuisance, and traffic effects associated with the works.

It is noted that rule 8.6.5.1.7 of the FNDP provides for construction noise as a permitted activity, provided the noise does not exceed the limits recommended in, and measured and assessed in accordance, with the New Zealand Standard NZ6803P:1984: “The Measurement and Assessment of Noise from Construction, Maintenance and Demolition Work” . The limits specified in this Standard will be complied with during all construction activities on the site.

Given the scale of the proposal, the construction period required for site preparation, construction work (including earthworks), and disestablishment, is expected to take at least two earthworks construction seasons (up to 8 months) or potentially more depending on weather conditions. This does not include the time required to undertake replanting and ecological offsetting and compensation plan or reservoir commissioning.

Traffic generated during the construction phase will involve transportation of heavy vehicles onto the site during the phase of site establishment, contractor vehicles entering and exiting the site on a daily basis during construction works, and transportation of heavy vehicles off the site on completion of works. Once commissioned, there is expected to be very little traffic generation (<2 vehicles per day) associated with the on-going operation of the reservoir. It is noted that the KDP rules exclude traffic movements associated with construction activities.

However, to provide some certainty regarding the extent of these effects and to mitigate any potential adverse effects that may arise, the applicant intends to prepare and implement a CMP (refer **Section 3.4**).

7.5.2 Construction Stormwater Effects

When sediment enters water, it can have a number of adverse effects on the stream environment. For example, sediment can:

- Act as a carrier of nutrients, particularly phosphorus.
- Smother aquatic organisms, habitats and food sources.
- Cause discoloration of the water, detracting from its aesthetic qualities.
- Reduce light penetration and damage habitat value for fish and plant life.
- Clog filters and machinery if the water is used for water supplies and lead to an unacceptable drinking quality.
- Reduce the water carrying capacity of streams, increasing their susceptibility to flooding.

An ESCMP will be prepared, as part of the CMP, by the lead contractor and implemented during the construction phase. The ESCMP will be prepared in accordance with best practice and will include a range of industry best practice controls (refer **Section 3.4**). These may include silt fences, decanting earth bunds, cleanwater diversion bunds (cut-offs) and immediate re-grassing of the site on completion. Erosion and sediment controls will be in place until the site has been re-vegetated/ stabilised.

Using industry best practice controls will ensure the effects of earthworks, reservoir grades and embankment formation are no more than minor.

7.5.3 Operational Stormwater Management

Stormwater entering the reservoir could, if not appropriately managed, cause erosion of key parts of the infrastructure and impact on its integrity over time.

An ORMP will be prepared to support operation of the reservoir as set out in **Section 3.5** in accordance with its design standards. The ORMP will provide methods, procedures, inspection details and reporting forms for all operational aspects of the Te Ruaotehauhau Reservoir system. The ORMP will be provided to Councils for certifying and will be reviewed in accordance with industry best practice. An annual report on the monitoring and functioning of the reservoir will be provided annually to Council.

No more than minor effects are expected when operating the Te Ruaotehauhau Reservoir in accordance with the ORMP.

7.6 Risks to People and Property through Natural Hazards

RILEY has completed a Potential Impact Classification (PIC) assessment in accordance with the New Zealand Dam Safety Guidelines ((New Zealand Society on Large Dams (NZSOLD), 2015). RILEY's report is attached at **Appendix E**. A PIC assessment considers the consequences of an uncontrolled release of a reservoir's contents as a result of a dam breach. It is important to note that, as RILEY states, PIC assessments are **independent** of the likelihood or a failure, which, for a suitably designed, constructed, and operated dam, should be very low.

RILEY determined dam breach characteristics and undertook hydraulic modelling to determine a 'high' PIC for the proposed Te Ruaotehauhau Water Storage Reservoir, given that the likely damage level is major, and the population at risk is more than 100.

The detailed dam design has yet to be completed but will be required to support an application for a building consent to authorise the construction of the reservoir under the Building Act 2004. The dam will be designed in accordance with the highest design standards.

7.7 Assessment Summary

Constructing and operating the proposed Te Ruaotehauhau Water Storage Reservoir will result in significant social and economic benefits through the provision of sufficient and reliable volumes of water to enable conversion of pastoral land uses to horticulture.

The proposed reservoir is expected to have no more than minor adverse effects on landscape and amenity values if landscape and ecological mitigation measures are completed as proposed, and that the temporary effects will be no more than minor. Similarly, it is considered that adverse effects associated with discharges, risks to people and property, and damage or destruction of historic heritage values will be no more than minor if the reservoir is constructed and operated in accordance best practices guidelines and standards.

The construction of the reservoir will result in the permanent loss of the modified watercourses within the reservoir footprint and the loss of a small natural wetland the footprint. There is also potential for more than minor to significant adverse effects on aquatic and terrestrial fauna. However, the applicant has identified and proposed mitigation, offsetting, and compensation measures that are intended to minimise the overall loss of flora and fauna such that the adverse effects will be no more than minor – minor (refer **Appendix F**).

In summary, it is considered that the proposal will generate an acceptable level of adverse environmental effects on the receiving environment, while generating a significant level of positive effects.

8. Consultation and Notification

Te Tai Tokerau Water Trust engaged and consulted several groups and people regarding the project. This section provides an overview of what has been done to date.

8.1 Landowners and Occupiers of the Project Site

Employees of the applicant went to each property to meet with landowners individually as soon as their properties were determined to be of interest as a potential storage site.

Initially the owners of Hariru B & Poukai A Block (record of title NA15B/55) were spoken with about the reservoir but redesign of the reservoir meant that this property was no longer directly affected.

Trustee Mr McCully along with two Trust employees met with landowners at their individual properties to discuss the proposed reservoir concept.

Regular dialogue was had with landowners about access to site for technical investigations from February 2020.

Ongoing liaison continues, generally this has been on a weekly basis with regard to land acquisitions.

8.2 Local Authorities

The local authorities with responsibilities in this Project area are the NRC and KDC.

8.2.1 Northland Regional Council

NRC was responsible for delivering the outputs required under the funding agreement with Ministry of Business, Innovation, and Employment (MBIE) for the prefeasibility phase of the NWSUP. Chief Executive Officer, Mr Malcolm Nicholson, was a member of the Project Steering Group for the NWSUP Prefeasibility Phase.

While NRC are no longer the responsible for the NWSUP feasibility phase, the applicant continues to engage with the council for the purposes of preparing this application for resource consents, including:

- Meetings and phone calls with Stuart Savill, Consents Manager, to discuss consenting approach. The most recent meeting with Mr Savill was held 20th August 2020.
- Seeking a technical peer review of WWLA Hydrology Studies by independent experts (Tonkin & Taylor Ltd) commissioned by NRC.
- Through the Project Advisory Group, which has NRC staff member.

8.2.2 Far North District Council

FNDC Chief Executive Officer, Mr Shaun Clarke, was a member of the Project Steering Group for the NWSUP prefeasibility phase.

FNDC also had a member of staff, Mr Greg Wilson, on the Project Management Group (PMG), with other FNDC staff attending Project Management Group meetings on an ‘as required’ basis, as documented in minutes (copies of meeting minutes can be provided upon request).

Ms Chris Sargent was nominated as a Project Advisory Group member as was Ms Rachel Ropiha and Mr Ted Wihongi. They attended and participated in Project Advisory Group meetings, as documented in minutes.

Most recently, a conference call meeting was held involving Mr Ben Tait (WWLA), and Ms Louise Wilson (FNDC, Resource Consents Department) and Ms Trish Routley (FNDC, Resource Consents Department) on 21 August 2020 to discuss the proposed consenting approach.

8.3 Iwi Authorities

The relevant Iwi Authority is Te-Rūnanga-ā-Iwi-o-Ngāpuhi. It is also noted that Taiāmai ki te Takutai Moana is a charitable trust that represents all hapū of Taiāmai ki te Marangai that tātai to the whenua for the purposes of the RMA. Their whenua is identified in **Figure 6**.

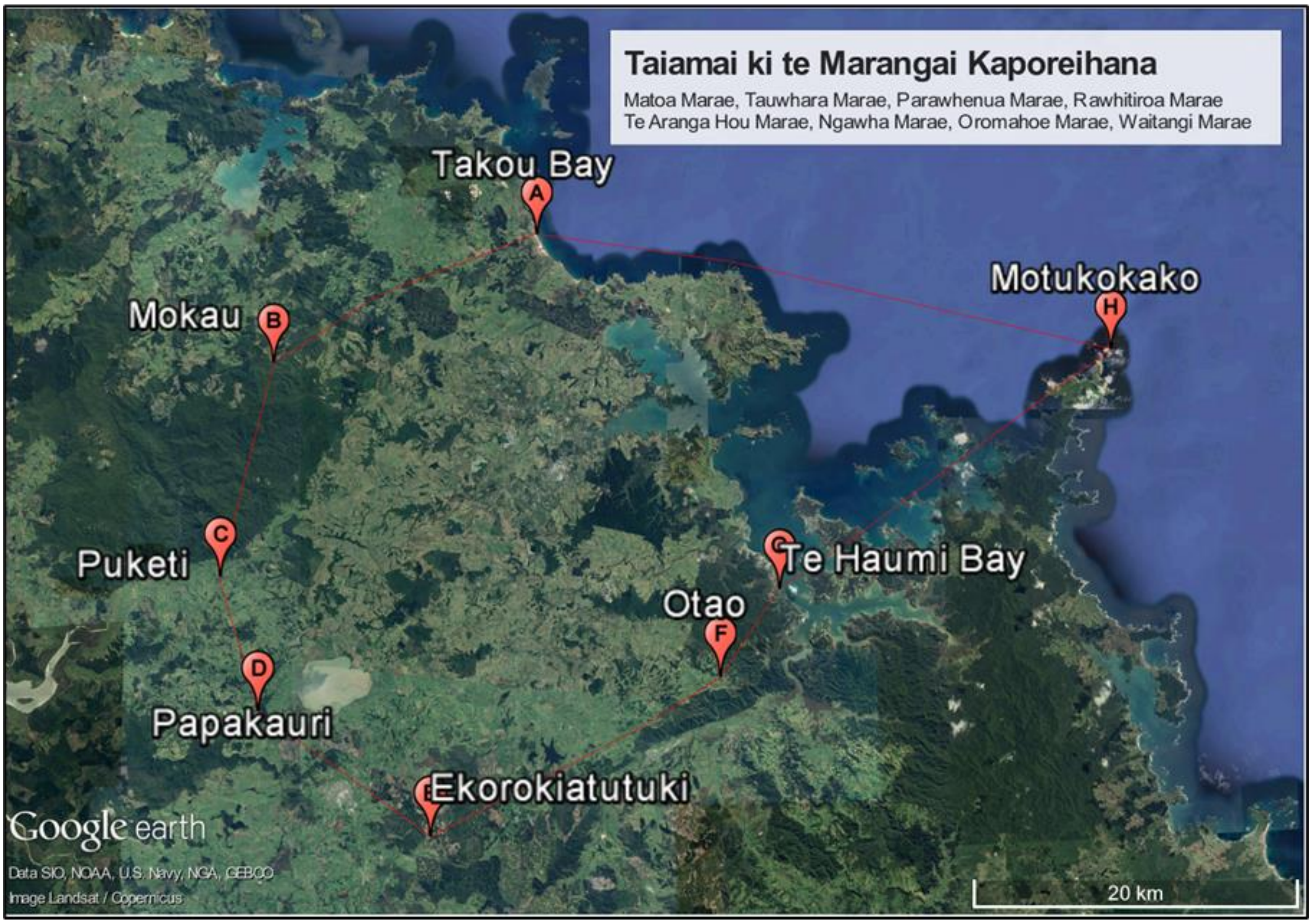

Figure 6. Whenua of Taiāmai ki te Takutai Moana

Engagement with iwi and hapū on the NWSUP began around June and July 2019 and included invitations to participate in the project with opportunities for Iwi and hapū involvement on both the management and advisory groups. Specifically, Mr Sonny Tau as Chairman of Te-Rūnanga-ā-Iwi-o-Ngāpuhi (at that time) was invited to participate in the NWSUP, first in a letter dated 5th July 2019, followed by a meeting held later in 2019.

Ms Mere Mangu was officially announced as Chairwoman of Te Rūnanga-ā-Iwi-o-Ngāpuhi on 17th December 2019 following a tikanga Māori process led by kaumatua. She had been acting chairwoman since October 2019 following the sudden resignation of Mr Tau who had chaired the organisation since 2009.

Te-Rūnanga-ā-Iwi-o-Ngāpuhi maintained their position on the Project Advisory Group but also passed on nominations to takiwā trustees with regular attendance documented in the minutes from the following takiwā trustees:

- Te Rau Allen (Taiāmai ki te Marangai) or alternate, Arnold Maunsell.
- Keith Wihongi (Ngāpuhi ki te Hauāuru).
- Nicole Anderson (Ngā Ngaru o Hokianga).
- Bernadette Birch (Ngāpuhi Hokianga ki te Raki).

Respective attendance and participation in the PAG meetings of these persons, or their representatives, is recorded in the minutes (copies can be supplied upon request).

As the NWSUP transitioned proposed Te Ruaotehauhau Water Storage Reservoir to the feasibility Phase, an initial hui was held at the Te-Rūnanga-ā-Iwi-o-Ngāpuhi boardroom on 7th August 2020 with the following whanau of Taiāmai ki te Marangai Kaporeihana rohe and specifically Ngā hapū o Te Ahuahu present:

- Arnold Maunsell;
- Hera Dear-Tapsell;
- Hone Tiatoa;
- Steve McManus (as hapū kaitiaki);
- Rio Greening;
- Trina Upperton;

A follow up hui was held at the Pewhairangi (Bay of Islands) Department of Conservation office on 21 August 2020 with the same whanau, with the exception of whaea Hera Dear-Tapsell.

Whanau found both hui very informative, with the sharing of technical expert findings really helpful to the development of their cultural impact assessment

The Project's Lead Ecologist (Dr Martin Neale) had regular email and phone contact since the two hui with Matua McManus. It is understood that Matua McManus would an offsetting plan as part of constructing the proposed reservoir, provided it considers the local context and issues. These include the traditional plants and gardening (e.g. taro and harakeke), passage for tuna into the reservoir and habitat enhancement for species (particularly tuna and kiwi) – all things that were raised in the two hui. Matua McManus is writing a short report on ecological issues for the hapū.

Matua McManus is also closely working with the Project's Lead Archaeologist (Jonathan Carpenter) given the presence of archaeological features at the site.

One of the key areas that Matua McManus considers highly important is the continued involvement of himself and the hapū to be involved as the project, including the planned offsetting, progresses. This will be a key tenet of the cultural impact assessment.

The Resource Management Unit of the Taiāmai ki te Takutai Moana is preparing a cultural impact assessment on behalf of Ngā Hapū, with close oversight by Matua McManus, and it will include evidence from Te-Rūnanga-ā-Iwi-o-Ngāpuhi that the assessment is also prepared on behalf of the Iwi Authority as is required under the Act.

Figure 7. Matua McManus and Jonathan Carpenter (Project's Lead Archaeologist) as the site of the proposed Te Ruaotehauhau Water Storage Reservoir during a site visit (August 2020).

8.3.1 Treaty Settlements

In 2009, Te Roopu o Tuhoronuku was authorised by Te-Rūnanga-ā-Iwi-o-Ngāpuhi to begin the process of seeking a mandate for direct negotiations with the Crown. In 2010 a series of information hui were held around New Zealand and in Australia. In 2011 Ngāpuhi, were given the opportunity to participate in a mandating process. Of the 29,389 Ngāpuhi who received voting packs, 23% voted. Of that number that voted, 76% supported Te Roopu o Tuhoronuku receiving a mandate for direct negotiations with the Crown. However, 24% voted against a mandate being granted. The government's believed that the level of opposition was too high for it to proceed, given the inevitability of court challenges.

A new mandating process was floated to give Government confidence that there is broad-based support for settlement negotiations. In December 2019, Ministers Little and Mahuta invited:

- mandate proposals from regional hapū groupings to negotiate cultural redress; and
- mandate proposals to negotiate collective matters (such as He Wakaputanga, te reo Māori, and financial and commercial redress).

Ministers consider there are common issues across ngā hapū o Ngāpuhi that would be better addressed in a collective negotiation.

A revised electoral process, with hapū grouped, and bound, by whakapapa and history, is still underway. At the time of lodgement of this application, no Treaty settlement currently applies to the project area.

8.4 Department of Conservation

The Department of Conservation (DoC) has a statutory advocacy role with regard to the conservation of natural and historic resources under the Conservation Act 1987, and also administers the Reserves Act 1977. Because the footprint of the proposed reservoir contains areas of indigenous vegetation and habitats of indigenous species, DoC may be considered affected.

DoC nominated Mr Stephen Soole to the Project Advisory Group during the NWSUP prefeasibility phase to advise on matters concerning DoC and to communicate the plans being scoped as part of the pre-feasibility work back to relevant people at DoC.

Mr Soole's attendance and participation at PAG meetings has been recorded through meeting minutes. Copies of these minutes can be provided upon request.

8.5 Northland Fish and Game Council

Mr Rudi Hoetjes, Manager of the Northland Fish and Game Council, was invited to participate as a member of the Project Advisory Group in a letter dated 8th July 2019. Mr Hoetjes nominated Daryl Reardon, Northland Fish and Game councillor, to the Project Advisory Group. Mr Reardon's attendance and participation within the group is recorded in the minutes (copies of which can be provided upon request). From the minutes reviewed, Mr Reardon did not raise any concerns or issues with the NWSUP as a group member.

Mr Reardon remains an active member of the Project Advisory Group having been invited to attend the past meeting held since the NWSUP progressed some sites to the feasibility phase.

8.6 Maori Landowners

One of the key investment principles of the PGF for the NWSUP prefeasibility phase is that water storage helps to address disparities in Maori access to water for land development.

Analysis of the command area of the long-list of potential storage sites indicated that there are approximately 1,000 hectares of Māori Freehold Land in over approximately 600 trusts or individual ownership. Initial discussions with some of the landowners have confirmed that they are interested in developing their land should a reliable water source be available. Multiple hui have been held with various Māori groups, including trusts, marae, and hapū. Input from hapū and Iwi on the Project Advisory Group has helped identify opportunities and challenges for Māori to benefit from a water supply scheme.

8.7 Downstream Landowners and Occupiers

To date, no consultation has been undertaken with downstream landowners and occupiers.

9. Proposed Monitoring

Clause 6(1)(g) of Schedule 4 of the RMA requires a description of how and by whom the effects of an activity will be monitored if the activity is approved if the scale and significance of the activity's effects are such that monitoring is required.

Table 23 summarises the proposed monitoring, which are the subject of proposed consent conditions (refer **Appendix J**)

Table 23. Proposed monitoring

Monitoring	Responsibility
Installation erosion and sediment control measures	The applicant or its agent
Inspection of erosion and sediment control measures	NRC and/or FNDC's compliance monitoring manager
Construction water quality monitoring	The applicant or its agent
Long-term water quality monitoring	The applicant or its agent
Water quantity monitoring (reservoir levels, continuation flows, and water takes)	The applicant or its agent
Dam inspections (as per NZSOLD)	The applicant or its agent
Monitoring of the implementation of flora and fauna management plans and the Offset and Compensation Plan	The applicant or its agent
Post-dam construction eel monitoring	The applicant or its agent

10. Conclusion

There is a demonstrated need for water storage infrastructure in the Mid-North to unlock sustainable long-term productive outcomes and jobs, thereby stimulating the economy in part of the country's most impoverished areas. The proposal Te Ruaotehauhau Water Storage Reservoir will improve economomic outcomes for people in the Mid-North community by creating jobs and generating secondary economic stimulus and social wellbeing.

Developing water storage capacity will minimise effects on surface water bodies and create enduring infrastructure to stimulate primary industry development in the region whilst providing for the foreseeable future needs of the community in accordance with Te Mana o Te Wai.

The applicant is seeking various resource consents from NRC and FNDC to authorise the construction and operation of Te Ruaotehauhau Water Storage Reservoir. The activities for which resource consents are sought range in classification from restricted discretionary to non-complying. Therefore, the overall activity status of the proposal is non-complying (because of the relevance of regulation 54 in the NES-FW).

Subject to the proposed conditions (refer **Appendix J**), the actual and potential effects on the environment are considered to be no more than minor, with most adverse effects able to be avoided, remedied, or mitigated. Furthermore, the proposal is not contrary to relevant objectives and policies in the PRP and RWSP.

It is considered that the consent authority should grant resource consents to authorise the construction and operation of Te Ruaotehauhau Water Storage Reservoir in accordance with section 104D of the RMA.

Appendix A. Application Forms

See attached

Appendix B. Records of Title

See attached

Appendix C. Hydrological Assessment Report

See attached

Appendix D. Geotechnical and Site Suitability Assessment Report

See attached

Appendix E. Hydrology and Hydraulic Assessment Report

See attached

Appendix F. Ecological Assessment Report

See attached

Appendix G. Landscape and Visual Amenity Assessment Report

See attached

Appendix H. Archaeological Assessment Report

See attached

Appendix I. Contaminated Land Review

See attached

Appendix J. Proposed Conditions of Consent

See attached

Appendix B. Records of Title

Application No.: ....
Office Use Only

PO: ....

Application for a Resource Consent – Resource Management Act 1991

This application form must be provided with applications to the council for new and replacement resource consents, and changes to the conditions on an existing resource consent.

If you would like to talk or meet with a consents officer to discuss your application prior to lodging with the council, please phone **0800 002 004** or email request to **info@nrc.govt.nz**.

PART 1: Administration Matters

1 **Full Name of Applicant(s)** *(the name(s) that will be on the resource consent document)*

Surname: ....

First Names: ....

OR

If the application is being made on behalf of a trust, the Trustee(s) who has/have signing authority for the trust must be named.

Trust Name: Te Tai Tokerau Water Trust

Trustee's Name(s): Mr Murray McCully

OR

Company Name: ....

Contact Person: ....

Email address: c/o Andrew.Carvell@taitokerauwater.com

Please Note: If an email address is provided, then all correspondence for this application will be via email.

Postal address: 6 Woods Road, Whangarei 0110, New Zealand

Telephone: *(please tick preferred contact number)*

☐ Residential ....

☐ Business ....

☐ Mobile 022 540 8714

Northland REGIONAL COUNCIL
Te Kaunihera ā rohe o Te Taitokerau

2 Details of the Address for Service of documents if different from the Applicant (e.g. Consultant). This address will be used for all documents if completed.

Company Name: Williamson Water & Land Advisory

Contact Person: Ben Tait

Email address: ben.tait@wwla.kiwi

Please Note: ***If an email address is provided, then all correspondence for this application will be via email.***

Postal address:

Telephone: *(please tick preferred contact number)*

☐ Residential ☐ Business

☑ Mobile 027 430 9020

3 Invoices

Charges relating to the processing of this resource consent application should be sent to:

☑ Applicant ☐ Address for service

Charges relating to the ongoing monitoring of a resource consent should be sent to:

☑ Applicant ☐ Address for service

4 Name and Address of all Owners/Occupiers of the Site relating to Application if different from the Applicant

Owner(s): Please see Section 3.2 of the attached document titled "Application for Resource Consents To Construct & Operate Te Ruaotehauhau Water Storage Reservoir"

Postal Address:

Telephone: *(please tick preferred contact number)*

☐ Residential ☐ Business

☐ Mobile

Occupier(s): Please see Section 3.2 of the attached document titled "Application for Resource Consents To Construct & Operate Te Ruaotehauhau Water Storage Reservoir"

Postal Address:

Telephone: *(please tick preferred contact number)*

☐ Residential ☐ Business

☐ Mobile

Please Note: ***If the applicant is not the owner of the land to which the activity relates, then it is good practice to submit the application with written approval from the landowner.***

5 Extending Timeframes

The Resource Management Act 1991 (RMA) specifies timeframes for processing resource consent applications (e.g. 20 working days for a non-notified application); however, these timeframes can be extended, if necessary, with the Applicant's agreement. If the council does not meet these timeframes, then it is required to refund 1% of the total processing cost of the application for each day it exceeds the timeframe up to a maximum of 50%.

Do you agree to the council extending RMA resource consent processing timeframes?

☐ **Yes**, provided that I can continue to exercise my existing resource consent until processing of this application is completed.
(Replacement application only. No refund is required to be paid until after the existing resource consent expires.)

☑ **Yes**, provided that the extension is for the specific purpose of discussing and trying to agree on resource consent conditions.

☐ **Yes**, provided that the application process is completed before this date (dd/mm/yy):

☐ No.

6 Deposit Fee

An initial minimum fee is payable with this application. These fees can be found on the council's website www.nrc.govt.nz – **Schedule of Minimum Estimated Initial Fees** information. Please contact council consents staff if you need assistance with determining the correct minimum initial fee.

Unless agreed to prior to lodging your application, the council will not commence processing your resource consent application until payment of the minimum initial fee is received (i.e. the statutory processing time for the application will not start).

This minimum initial fee may be paid online, by cheque, or by EFTPOS at one of the council's offices.

Instructions for paying online can be found on the council's website at "Pay online". Please use either the first six numbers of your resource consent (e.g. CONXXXXXX or AUT.XXXXXX), if known, or the Applicant's name as the Reference/Customer number when paying online.

If you do pay online, then please enclose evidence of payment so that the council is aware that the payment has been made.

If the costs of processing the resource consent application are greater than the minimum estimated initial fee, then the applicant will be required to pay the additional actual and reasonable costs of processing the application.

Note: Annual User Charges for Resource Consent Holders

Holders of resource consents will in most cases be required to pay a "Minimum Annual Charge" for administration of the resource consent once issued. There is also likely to be additional annual charges for the monitoring of the resource consent, which will be dependent on the type of activity the resource consent is for. These charges are detailed on the council's website www.nrc.govt.nz in the Annual Charges section of the council's **Charging Policy**.

7 Applications for Activities within the Coastal Marine Area (CMA)

Prior to lodging an application with the council to undertake any activity in the coastal marine area (CMA), the applicant is required under the Marine and Coastal Area (Takutai Moana) Act 2011 to notify the application to all groups who have applied for customary marine title in that location, and seek their view on the application. This notification should, as a minimum, include a summary of the application that provides sufficient detail for a group to understand what is being proposed

The council cannot accept an application to undertake an activity in the CMA unless the applicant for the resource consent provides evidence of this notification occurring. A response from customary marine title groups is not required by the council.

To ensure you meet the above requirement, you are advised to contact council consents staff to obtain a list of all of the current customary marine title applicant groups within the area where you are proposing to apply for a resource consent.

Information on customary marine titles is available on the **Ministry of Justice/Marine and Coastal Area Applications** website.

8 Consultation

The RMA does not require any person, including the applicant or council, to consult with anyone. It is, however, best practice to do so and will allow the council to make a more informed decision.

It is important to remember that consultation does not require reaching an agreement – it is to allow you and the council to be informed about a person’s views. If you do consult, and there are concerns raised that cannot be resolved and you still want to go ahead with your application, then you should have made a genuine attempt to consult with that person(s) in an open and honest manner. Their views should be recorded so they can be taken into account by the council when considering your resource consent application.

PART 2: Application Details

1 Description of Activity

Please describe in detail the activity for which resource consent is being sought.

Please see the attached document titled "Application for Resource Consents To Construct & Operate Te Ruaotehauhau Water Storage Reservoir"

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2 Location Description of Activity

Site Address: Please see the attached document titled "Application for Resource Consents To Construct & Operate Te Ruaotehauhau Water Storage Reservoir"

Legal Description: As above

(Legal description can be obtained from your Certificate of Title, valuation notice, or rates demand)

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3 Site Plan

On a separate page *(minimum A4 size)*, please provide a site plan showing the location of the activity, site layout, and surrounding environment in relation to property boundaries. Please include any buildings or developments on the site.

These plans should be provided electronically and be of good quality, to enable use in resource consent documentation.

If you do not have access to mapping software, we recommend you use the council's **"Property and Boundaries"** map available on our website https://localmaps.nrc.govt.nz/LocalMapsGallery/.

This council map contains aerial photography and shows property boundaries and details. You can carry out a property search and print maps of aerial photography.

---

4 Resource Consent(s) being Applied for

Coastal Permit

☐ Mooring

☐ Pipeline/Cable

☐ Marine Farm

☐ Other *(specify)*

☐ Structure

Land Use Consent

☐ Quarry

☑ Vegetation Clearance

☐ Other *(specify)*

☑ Earthworks

☐ Construct/Alter a Bore

☑ Dam Structure

☑ Structure in/over Watercourse

Water Permit

☑ Stream/Surface Take ☑ Damming ☑ Groundwater Take

☑ Diverting Water ☐ Other *(specify)* ....

Discharge Permit

☐ Domestic Effluent to Land ☑ General Discharge to Land ☐ Farm Dairy Effluent to Land/Water

☐ Air ☑ Water ☐ Other *(specify)* ....

---

5 Is this application to replace an existing or expired resource consent(s)? ☐ Yes ☑ No

If Yes:

(a) Please state the resource consent number(s):

....

....

(b) Do you agree to surrender the existing resource consent once a new one has been issued:

☐ Yes ☐ No

---

6 Is this application to change a condition of an existing resource consent? ☐ Yes ☑ No

If Yes, please state the resource consent number(s):

....

....

---

7 Please specify the duration sought for your resource consent(s) –

Only for new or replacement applications.

Please see Section 3.2 of the attached document titled "Application for Resource Consents To Construct & Operate Te Ruaotehauhau Water Storage Reservoir" years .... months

---

8 Do you also require consent(s) from a district council? ☑ Yes ☐ No

If Yes, please complete the following:

Type of consent required? Land use consents

Has it been applied for? ☑ Yes ☐ No

Has it been granted? *(If Yes, please attach)* ☐ Yes ☑ No

PART 3: Assessment of Environmental Effects (AEE)

1 An AEE must be provided with your application that has been completed in accordance with the requirements of Schedule 4 of the RMA.

As a minimum, your AEE must include the following:

- Description of the environmental effects of the activity.
- Description of ways in which adverse environmental effects can be avoided, remedied or mitigated.
- Names of people affected by the proposal.
- Record of any consultation you have undertaken, including with affected persons (if any).
- Discussion of any monitoring of environmental effects that might be required.
- An assessment of the activity against any relevant objectives, policies, or rules in the Regional Plans.
- For a coastal permit, an assessment of your activity against any relevant objectives and policies of the New Zealand Coastal Policy Statement.
- An assessment of effects on tangata whenua and their taonga.

This AEE needs to be provided in a separate document attached to this application form.

Any activity needing a resource consent will have some environmental effects. The council will not accept an AEE that says there are no environmental effects from the activity.

You will need to complete the AEE at a level that corresponds with the scale and significance of the effects that the activity may have on the environment. Depending on the scale of the activity, you may need to get help from an expert(s) to prepare your AEE.

The council has a set of standard AEE forms for a selection of common activities. These AEE forms do not cover the relevant objectives, policies, or rules in the Regional Plans nor effects on tangata whenua. If you use one of these forms, then you will need to provide a separate assessment of these matters. These AEE forms can be found on the council's website www.nrc.govt.nz – **"Forms and Fees"**.

It is important that you provide the council with a complete and well-prepared AEE, otherwise the council may not accept your application.

If your application is for a change to a condition of resource consent under Section 127 of the RMA, then your AEE only needs to cover the effects of the change being requested.

2 Assessment of Effects on tangata whenua and their taonga

The Regional Plan for Northland requires that an AEE must also include an assessment of the effects on tangata whenua and their taonga if one or more of the following is likely:

- Adverse effects on mahinga kai or access to mahinga kai; or
- Any damage, destruction or loss of access to wāhi tapu, sites of customary value and other ancestral sites and taonga with which Māori have a special relationship; or

- Adverse effects on indigenous biodiversity in the beds of waterbodies or the coastal marine area where it impacts on the ability of tangata whenua to carry out cultural and traditional activities; or
- Adverse effects on taiāpure, mātaitai or Māori non-commercial fisheries; or
- Adverse effects on protected customary rights; or
- Adverse effects on sites and areas of significance to tangata whenua mapped in the Regional Plan for Northland (refer Maps |Ngā mahere matawhenua).

Your AEE must include an assessment of whether any of the above affects are likely to occur.

If they are likely to occur, then you will need to complete a Cultural Impact Assessment (CIA) and provide this with your resource consent application. The Regional Plan for Northland provides details of what must be included in this CIA, and should be referred to.

The best way to find out what the effects of your proposal may be on tangata whenua is to contact local iwi/hapū groups (who represent tangata whenua) and discuss your proposal with them. Council consents staff can provide a list of contact details for local iwi/hapū groups in the area of your proposal. You can then send a copy of your proposal to these groups and seek feedback from them prior to lodging your application. Some iwi/hapū have also developed iwi/hapū Environmental Management Plans that are useful documents that can assist to identify issues of concern to those iwi/hapū for activities occurring in their rohe. The iwi/hapū Environmental Management Plans can be obtained directly from the iwi/hapū or from the council upon request.

3 Assessment of Affected Persons

If the adverse effects of your activity on a person are likely to be minor, or more than minor, then that person is deemed to be an “affected person” for your resource consent application.

An affected person may include neighbouring land owners and occupiers, and/or organisations such as the Department of Conservation, Land Information New Zealand (LINZ), Fish and Game Council, Iwi and Hapū, and community groups.

If you do not think there will be any affected persons for your resource consent application, then you do not need to provide any details on this matter in your AEE. However, the council will still undertake an assessment of whether there are any affected persons as part of processing the resource consent application.

If there are persons you have identified who may be affected, and you have discussed your proposal with these persons, please record any comments made by them and your response, and include this information with your application. If you have written approvals from these parties, then these should be provided as well. The council has a written approval form that can be used for this purpose.

Iwi Settlement Acts

If there is an **Iwi Settlement Act** that covers the area of your application, then there may be “Statutory Acknowledgement” areas which could be adversely affected by your activity. If the location of your activity is within, adjacent to, or may have an adverse effect on, a Statutory Acknowledgement area, then you will need to assess whether the trustees of the Statutory Acknowledgement are affected persons. Information about Statutory Acknowledgements in Northland can be found on the council’s webpage at “Statutory Acknowledgements in Northland”.

Checklist

The following information **must** be included in your application to ensure that is not returned as incomplete under Section 88 of the RMA.

☑ All applicable application form details have been completed.

☑ Assessment of Environmental Effects in accordance with Schedule 4 of the RMA.

☐ Assessment of effects on tangata whenua and their taonga.

☑ Site plan(s). These are required to be of good quality, and preferably electronically, to enable use in resource consent documentation.

☐ Evidence of payment of the required minimum estimated initial fee.

☐ If you are applying for a coastal permit, evidence that you have provided notice of your application to all groups who have applied for customary marine title in the location of your application and that you have sought their view on the application. The council cannot legally accept an application without evidence of this.

Information Privacy Issues

The information you provide in this application is regarded as official information. It is required under the provisions of the Resource Management Act 1991 to process this application. The information will be held by the council and is subject to the provisions of the Local Government Official Information and Meetings Act 1987, and the Privacy Act 1993. The information you provide in this application will generally be available to the public.

Under Section 88 and/or 127 of the Resource Management Act 1991 (RMA), the undersigned makes this application for resource consent(s).

1 I/We confirm that I have authority to sign on behalf of the person(s) named as the applicant(s) for this application for resource consent.

2 I/We have read, and understand, all of the information contained within this application form, including the requirement to pay any additional actual and reasonable costs for the processing of the application.

3 I/We confirm that all of the information provided is true and correct and I understand that any inaccurate information provided could result in my resource consent (if granted) being cancelled.

Signature(s): .... **Date:** 18/09/2020

Signature(s): .... **Date:** n

Signature(s): .... **Date:** ....

Please note that a signature is not required if submitting application electronically.

Far North District Council

Private Bag 752, Memorial Ave
Kaikohe 0440, New Zealand
Freephone: 0800 920 029
Phone: (09) 401 5200
Fax: (09) 401 2137
Email: ask.us@fndc.govt.nz
Website: www.fndc.govt.nz

Office Use Only
Application Number:

APPLICATION FOR RESOURCE CONSENT OR FAST-TRACK RESOURCE CONSENT

(Or Associated Consent Pursuant to the Resource Management Act 1991 (RMA))

(If applying for a Resource Consent pursuant to Section 87AAC or 88 of the RMA, this form can be used to satisfy the requirements of Form 9)

Prior to, and during, completion of this application form, please refer to Resource Consent Guidance Notes and Schedule of Fees and Charges – both available on the Council's web page.

1. Pre-Lodgement Meeting

Have you met with a Council Resource Consent representative to discuss this application prior to lodgement? Yes / No

2. Type of Consent being applied for (more than one circle can be ticked):

[✓ ○ Land Use] ○ Fast Track Land Use* ○ Subdivision ○ Discharge
○ Extension of time (s.125) ○ Change of conditions (s.127) ○ Change of Consent Notice (s.221(3))
○ Consent under National Environmental Standard (e.g. Assessing and Managing Contaminants in Soil)
○ Other (please specify) ______

***The fast track for simple land use consents is restricted to consents with a controlled activity status and requires you provide an electronic address for service.**

3. Would you like to opt out of the Fast Track Process? Yes / No

4. Applicant Details:

Name/s: Te Tai Tokerau Water Trust

Electronic Address for Service (E-mail): C/o Andrew.Carvell@taitokerauwater.com

Phone Numbers: Work: 022 540 8714 Home: ______

Postal Address: 6 Wood Road, Whangarei
(*or* alternative method of service under section 352 of the Act)
Post Code: 0110

5. Address for Correspondence: *Name and address for service and correspondence (if using an Agent write their details here).*

Name/s: Ben Tait

Electronic Address for Service (E-mail): ben.tait@wwla.kiwi

Phone Numbers: Work: 027 430 9020 Home: ______

Postal Address: Williamson Water & Land Advisory
(*or* alternative method of service under section 352 of the Act)
Unit 5A, Waimamauku Village Centre, 11F Factory Road
Auckland Post Code: 0812

All correspondence will be sent by email in the first instance. Please advise us if you would prefer an alternative means of communication.

6. Details of Property Owner/s and Occupier/s:

Name and Address of the Owner/Occupiers of the land to which this application relates (where there are multiple owners or occupiers please list on a separate sheet if required)

Name/s: See attached document titled "Application for Resource Consents To Construct & Operate Te Ruaotehauhau Water Storage Reservoir"

Property Address/: Location As above

7. Application Site Details:

Location and/or Property Street Address of the proposed activity:

Site Address/ Location: As above

Legal Description: Val Number:

Certificate of Title:

Please remember to attach a copy of your Certificate of Title to the application, along with relevant consent notices and/or easements and encumbrances (search copy must be less than 6 months old)

<u>Site Visit Requirements</u>:

Is there a locked gate or security system restricting access by Council staff? Yes / [✓ No]

Is there a dog on the property? Yes / [✓ No]

Please provide details of any other entry restrictions that Council staff should be aware of, e.g. health and safety, caretaker's details. This is important to avoid a wasted trip and having to re-arrange a second visit.

8. Description of the Proposal:

Please enter a brief description of the proposal here. Attach a detailed description of the proposed activity and drawings (to a recognized scale, e.g. 1:100) to illustrate your proposal. Please refer to Chapter 4 of the District Plan, and Guidance Notes, for further details of information requirements.

See attached document titled "Application for Resource Consents To Construct & Operate Te Ruaotehauhau Water Storage Reservoir"

If this is an application for an Extension of Time (s.125); Change of Consent Conditions (s.127) or Change or Cancellation of Consent Notice conditions (s.221(3)), please quote relevant existing Resource Consents and Consent Notice identifiers and provide details of the change(s) or extension being sought, with reasons for requesting them.

9. Would you like to request Public Notification

Yes/[✓ No]

10. Other Consent required/being applied for under different legislation (more than one circle can be ticked):

[✓ ○ Building Consent] (BC ref # if known)   [✓ ○ Regional Council Consent] (ref # if known)

[✓ ○ National Environmental Standard consent]   ○ Other (please specify)

11. National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health:

The site and proposal may be subject to the above NES. In order to determine whether regard needs to be had to the NES please answer the following (further information in regard to this NES is available on the Council's planning web pages):

Is the piece of land currently being used or has it historically ever been used for an activity or industry on the Hazardous Industries and Activities List (HAIL) ○ yes [✓ ○ no] ○ don't know

Is the proposed activity an activity covered by the NES? (If the activity is any of the activities listed below, then you need to tick the 'yes' circle). [✓ ○ yes] ○ no ○ don't know

○ Subdividing land   [✓ ○ Changing the use of a piece of land]

○ Disturbing, removing or sampling soil   ○ Removing or replacing a fuel storage system

12. Assessment of Environmental Effects:

Every application for resource consent must be accompanied by an Assessment of Environmental Effects (AEE). This is a requirement of Schedule 4 of the Resource Management Act 1991 and an application can be rejected if an adequate AEE is not provided. The information in an AEE must be specified in sufficient detail to satisfy the purpose for which it is required. Your AEE may include additional information such as Written Approvals from adjoining property owners, or affected parties.

Please attach your AEE to this application.

13. Billing Details:

This identifies the person or entity that will be responsible for paying any invoices or receiving any refunds associated with processing this resource consent. Please also refer to Council's Fees and Charges Schedule.

Name/s: (please write all names in full) Te Tai Tokerau Water Trust, c/o Andrew Carvell

Email: andrew.carvell@taitokerauwater.com

Postal Address: 6 Woods Road, Whangarei

Post Code: 0110

Phone Numbers: Work: 022 540 8714 Home: Fax:

Fees Information: An instalment fee for processing this application is payable at the time of lodgement and must accompany your application in order for it to be lodged. Please note that if the instalment fee is insufficient to cover the actual and reasonable costs of work undertaken to process the application you will be required to pay any additional costs. Invoiced amounts are payable by the 20th of the month following invoice date. You may also be required to make additional payments if your application requires notification.

Declaration concerning Payment of Fees: I/we understand that the Council may charge me/us for all costs actually and reasonably incurred in processing this application. Subject to my/our rights under Sections 357B and 358 of the RMA, to object to any costs, I/we undertake to pay all and future processing costs incurred by the Council. Without limiting the Far North District Council's legal rights if any steps (including the use of debt collection agencies) are necessary to recover unpaid processing costs I/we agree to pay all costs of recovering those processing costs. If this application is made on behalf of a trust (private or family), a society (incorporated or unincorporated) or a company in signing this application I/we are binding the trust, society or company to pay all the above costs and guaranteeing to pay all the above costs in my/our personal capacity.

Name: Andrew Carvell (please print)

Signature: (signature of bill payer – **mandatory**) Date: 18 September 2020

14. Important Information:

Note to applicant

You must include all information required by this form. The information must be specified in sufficient detail to satisfy the purpose for which it is required.

You may apply for 2 or more resource consents that are needed for the same activity on the same form.

You must pay the charge payable to the consent authority for the resource consent application under the Resource Management Act 1991.

Fast-track application

Under the fast-track resource consent process, notice of the decision must be given within 10 working days after the date the application was first lodged with the authority, unless the applicant opts out of that process at the time of lodgement. A fast-track application may cease to be a fast-track application under section 87AAC(2) of the RMA.

Privacy Information:

Once this application is lodged with the Council it becomes public information. Please advise Council if there is sensitive information in the proposal. The information you have provided on this form is required so that your application for consent pursuant to the Resource Management Act 1991 can be processed under that Act. The information will be stored on a public register and held by the Far North District Council. The details of your application may also be made available to the public on the Council's website, www.fndc.govt.nz. These details are collected to inform the general public and community groups about all consents which have been issued through the Far North District Council.

Declaration: The information I have supplied with this application is true and complete to the best of my knowledge.

Name: Ben Tait (please print)

Signature: ____________________ (signature) Date: 18 September 2020

(A signature is not required if the application is made by electronic means)

Checklist (please tick if information is provided)

○ Payment (cheques payable to Far North District Council)

○ A current Certificate of Title (Search Copy not more than 6 months old)

○ Copies of any listed encumbrances, easements and/or consent notices relevant to the application

○ Applicant / Agent / Property Owner / Bill Payer details provided

○ Location of property and description of proposal

○ Assessment of Environmental Effects

○ Written Approvals / correspondence from consulted parties

○ Reports from technical experts (if required)

○ Copies of other relevant consents associated with this application

○ Location and Site plans (land use) AND/OR

○ Location and Scheme Plan (subdivision)

○ Elevations / Floor plans

○ Topographical / contour plans

Please refer to Chapter 4 of the District Plan for details of the information that must be provided with an application. Please also refer to the RC Checklist available on the Council's website. This contains more helpful hints as to what information needs to be shown on plans.

Only one copy of an application is required, but please note for copying and scanning purposes, documentation should be:

UNBOUND **SINGLE SIDED** **NO LARGER THAN A3 in SIZE**

Appendix B. Records of Title

Map Title:

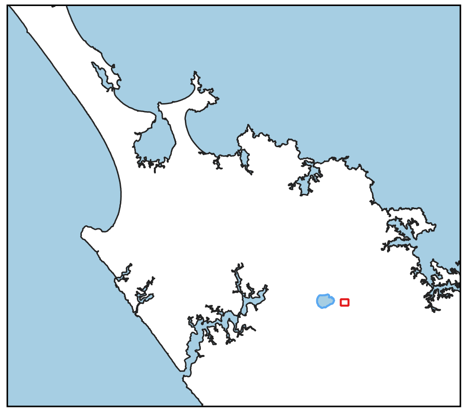
MN-06 Neighbouring Land Parcels

Project:

MN-06 Water Storage Reservoir Application

Client:

Te Tai Tokerau Water Trust



Legend

- ⬚ **Property Parcel**
- — **Indicative Spillway Location**
- — **Maximum Inundation Extent**
- ▭ **Full Supply Level**
- ▭ **Reservoir Embankment**

Data Provenance
Aerial Imagery: LINZ Northland 0.4m Aerial Imagery

Layout & Project File
MN06 Land Owner Map - Landscape
MN06_Land_Owner_Maps_for_Consent_Document.qgz

WILLIAMSON
WATER & LAND ADVISORY
Adding value through sustainable & efficient use of natural resources

RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD

Guaranteed Search Copy issued under Section 60 of the Land Transfer Act 2017

R.W. Muir
Registrar-General
of Land

Identifier	**NA53B/976**
Land Registration District	**North Auckland**
Date Issued	18 January 1983

Prior References
NA935/218

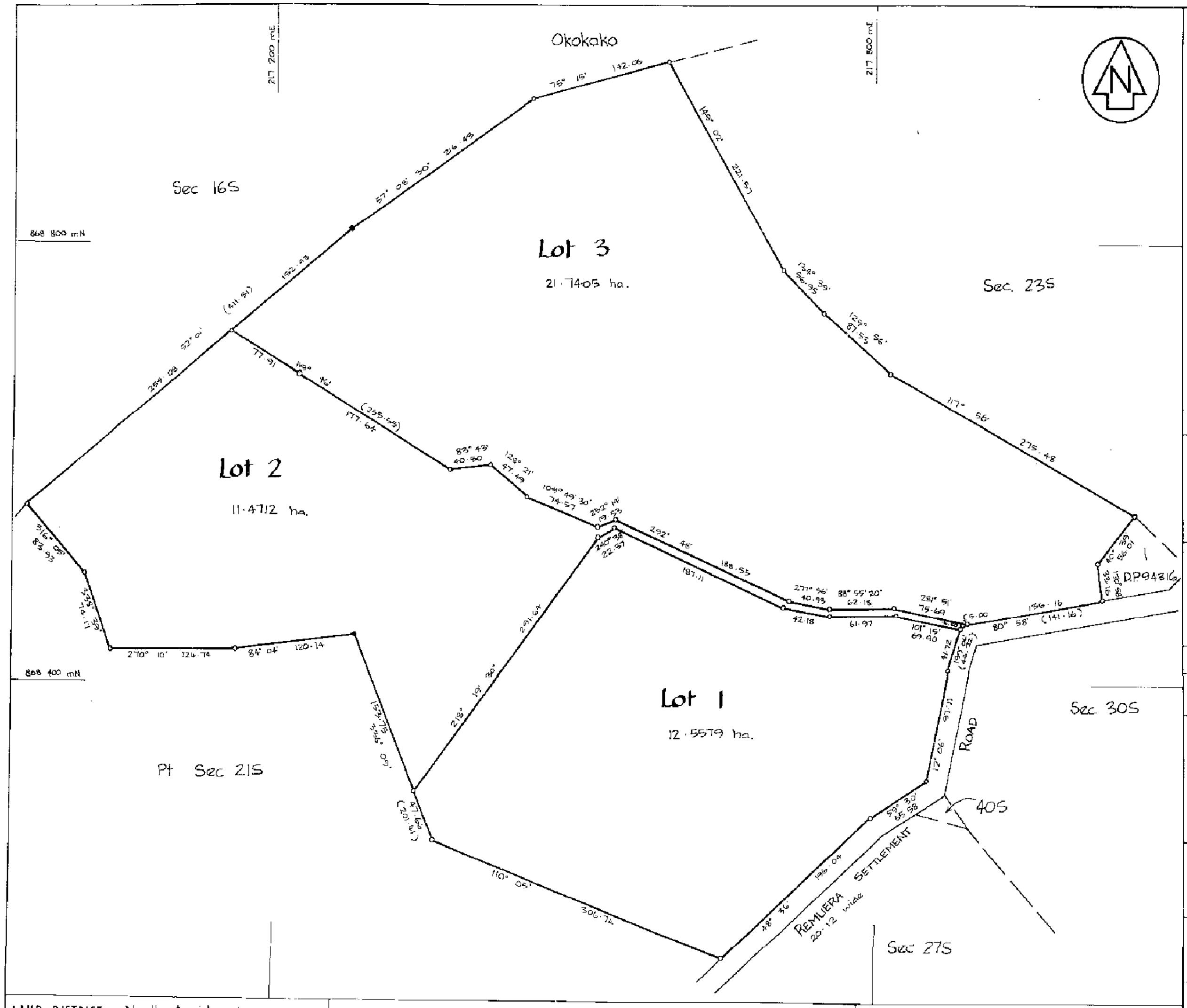
Estate	Fee Simple
Area	21.7405 hectares more or less
Legal Description	Lot 3 Deposited Plan 97908

Registered Owners
Mountain View Farms 2018 Limited

Interests

Subject to Section 206 Land Act 1924

11410890.2 Mortgage to Bank of New Zealand - 30.4.2019 at 4:36 pm



Approvals.

Road shown is legal.

Pursuant to a resolution of the Bay of Islands County Council passed on the 13th day of August 1982 approving pursuant to Section 305 of the Local Government Act 1974 this survey plan and certifying that the survey plan is in accordance with a consent granted under Part IV of the Town and Country Planning Act 1977 the common seal of the Bay of Islands County Council was affixed hereto in the presence of

Chairman

General Manager

New C.T.s Allocated
Lot 1 : 53B/974
Lot 2 : 53B/975
Lot 3 : 53B/976

Approved

Registered Owner

Total Area 45·7696 ha.

Comprised in C.T. 935/218 Bal.

I, Trevor James Shaw of Whangarei Registered Surveyor and holder of an annual practising certificate hereby certify that this plan has been made from Surveys executed by me or under my direction; that both plan and Survey are correct and have been made in accordance with the regulations under the Surveyors Act 1986

Dated at Kaikohe this 30th day of September 1982 Signature

Field Book p. Traverse Book p.

Reference Plans SO 20519, L.T. 94316

Examined Correct

Approved as to Survey

13/12/82 Chief Surveyor

Deposited this day of January 1983

District Land Registrar

File
Received
Instructions

D.P. 97903

LAND DISTRICT North Auckland
SURVEY BLK.& DIST. XII Omapere
NZMS 261 SHEET No. P05 / 4·3

Lots 1 - 3 being a subdivision of Pt Sec 22S Remuera Settlement

LOCAL AUTHORITY Bay of Islands County
Surveyed by Simpson, Shaw & Co
Scale 1:2500 Date July 1982

DATE OF PHOTOGRAPHY 3 FEB 1983

RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD
Limited as to Parcels
Guaranteed Search Copy issued under Section 60 of the Land Transfer Act 2017

R.W. Muir
Registrar-General
of Land

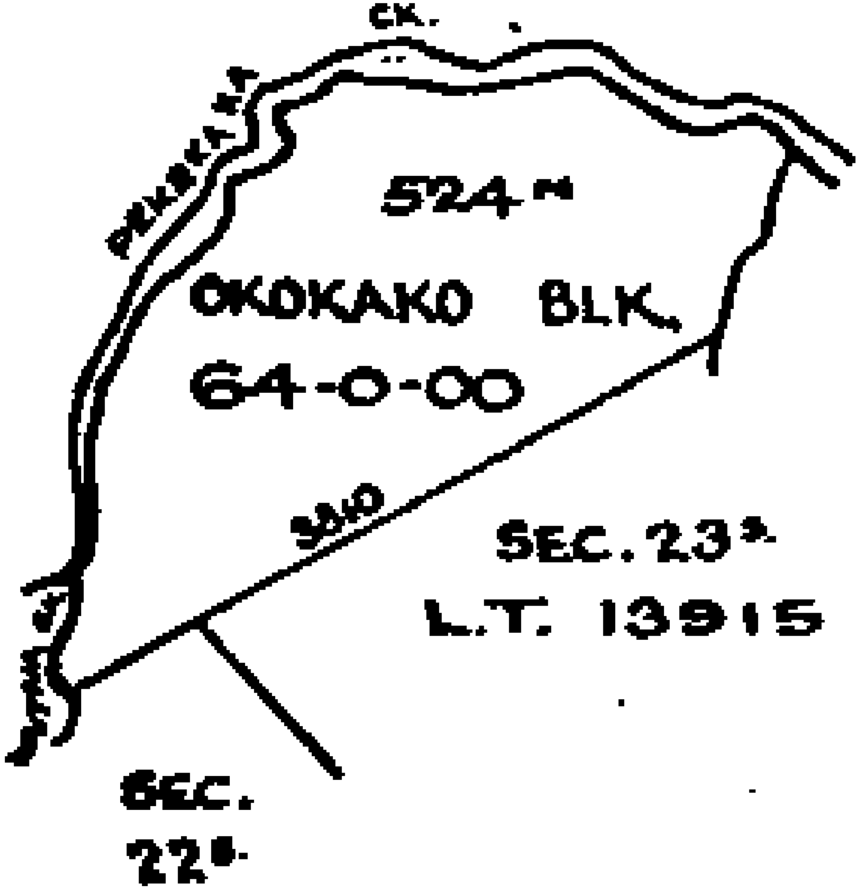
Identifier	**NA768/20**
Land Registration District	**North Auckland**
Date Issued	27 July 1944

Prior References
DI 1C.266

Estate	Fee Simple
Area	25.8999 hectares more or less
Legal Description	Okokako Block

Registered Owners
D.G. Dixon & Son Limited

Interests



METRIC AREA IS 25·899

RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD

Guaranteed Search Copy issued under Section 60 of the Land Transfer Act 2017

R.W. Muir
Registrar-General
of Land

Identifier NA1034/210
Land Registration District North Auckland
Date Issued 22 July 1952

Prior References
NAPR203/57 WA 5561

Estate Fee Simple
Area 43.5037 hectares more or less
Legal Description Section 16S Remuera Settlement

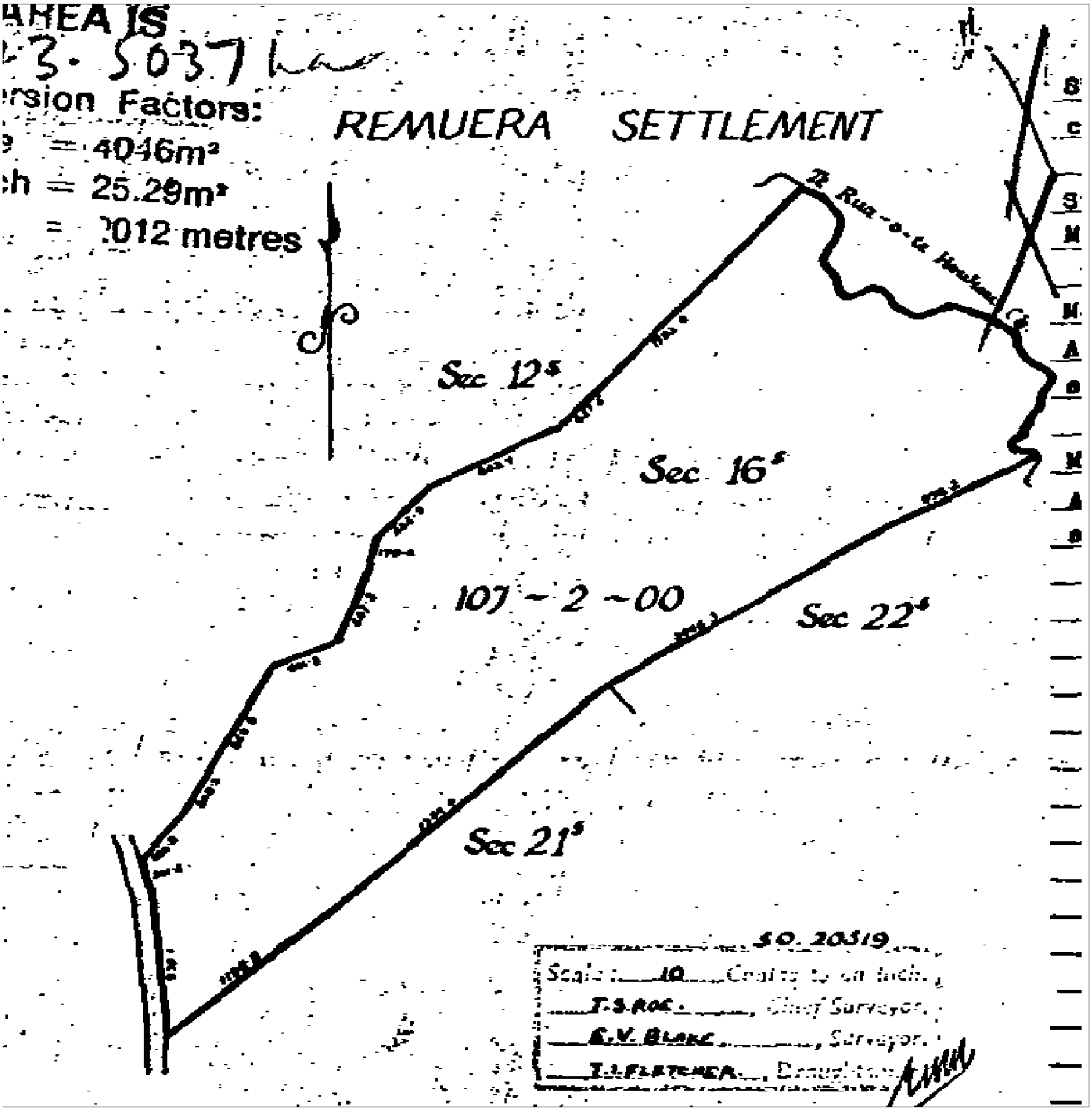
Registered Owners
Bruce Campbell Bell as to a 1/2 share
Helen Sheila Bell as to a 1/2 share

Interests

Subject to Section 206 Land Act 1924

Subject to Section 8 Coal Mines Amendment Act 1950

5611679.2 Mortgage to Bank of New Zealand - 6.6.2003 at 9:00 am



SO. 20519

Scale: 10 Chains to an inch.

T.S.Roe., Chief Surveyor.

C.V. Blake, Surveyor.

T.L.Fletcher, Draughtsman.

RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD

Guaranteed Search Copy issued under Section 60 of the Land Transfer Act 2017

R.W. Muir
Registrar-General
of Land

Identifier **552150**
Land Registration District **North Auckland**
Date Issued 15 November 2012

Prior References
NA388/229 NA388/280

Estate Fee Simple
Area 87.8420 hectares more or less
Legal Description Lot 2 Deposited Plan 442506

Registered Owners
D.G. Dixon & Son Limited

Interests

Subject to a right of way over part marked B and E on DP 442506 created by Court Order 3649

8999504.2 Consent Notice pursuant to Section 221 Resource Management Act 1991 - 15.11.2012 at 12:45 pm

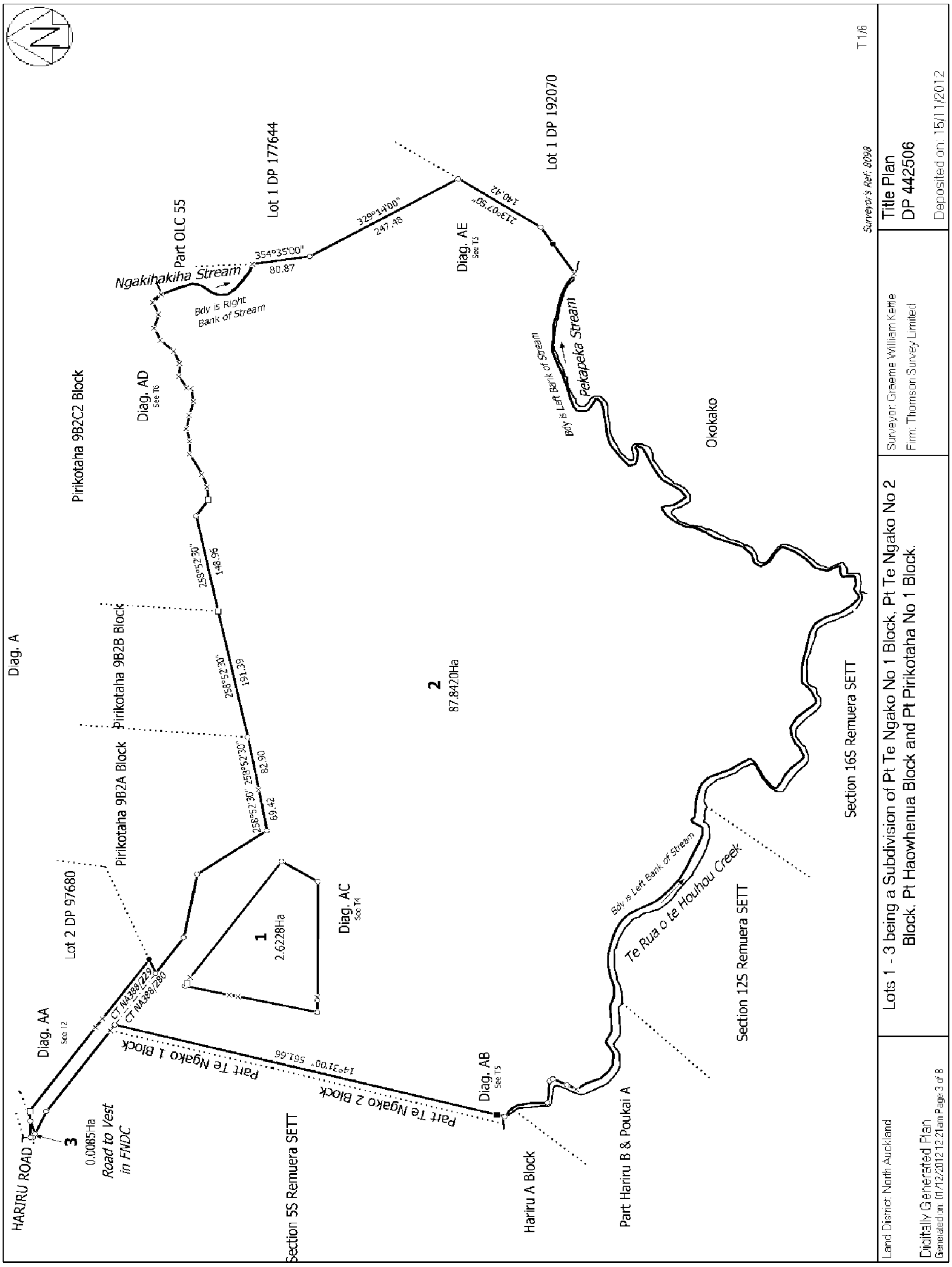
Subject to a right of way and a right to convey electricity, telecommunications and computer media and water over parts marked A, B and C on DP 442506 created by Easement Instrument 8999504.4 - 15.11.2012 at 12:45 pm

Some of the easements created by Easement Instrument 8999504.4 are subject to Section 243 (a) Resource Management Act 1991 (See DP 442506)

Subject to a right to convey electricity, telecommunications and computer media over parts marked D, E and F and a right to convey electricity and water over part marked G all on DP 442506 created by Easement Instrument 8999504.5 - 15.11.2012 at 12:45 pm

Subject to a right (in gross) to convey electricity, telecommunications and computer media over parts marked A and D on DP 442506 in favour of Top Energy Limited created by Easement Instrument 8999504.6 - 15.11.2012 at 12:45 pm

Land Covenant in Easement Instrument 8999504.7 - 15.11.2012 at 12:45 pm



Surveyor's Ref: 8098

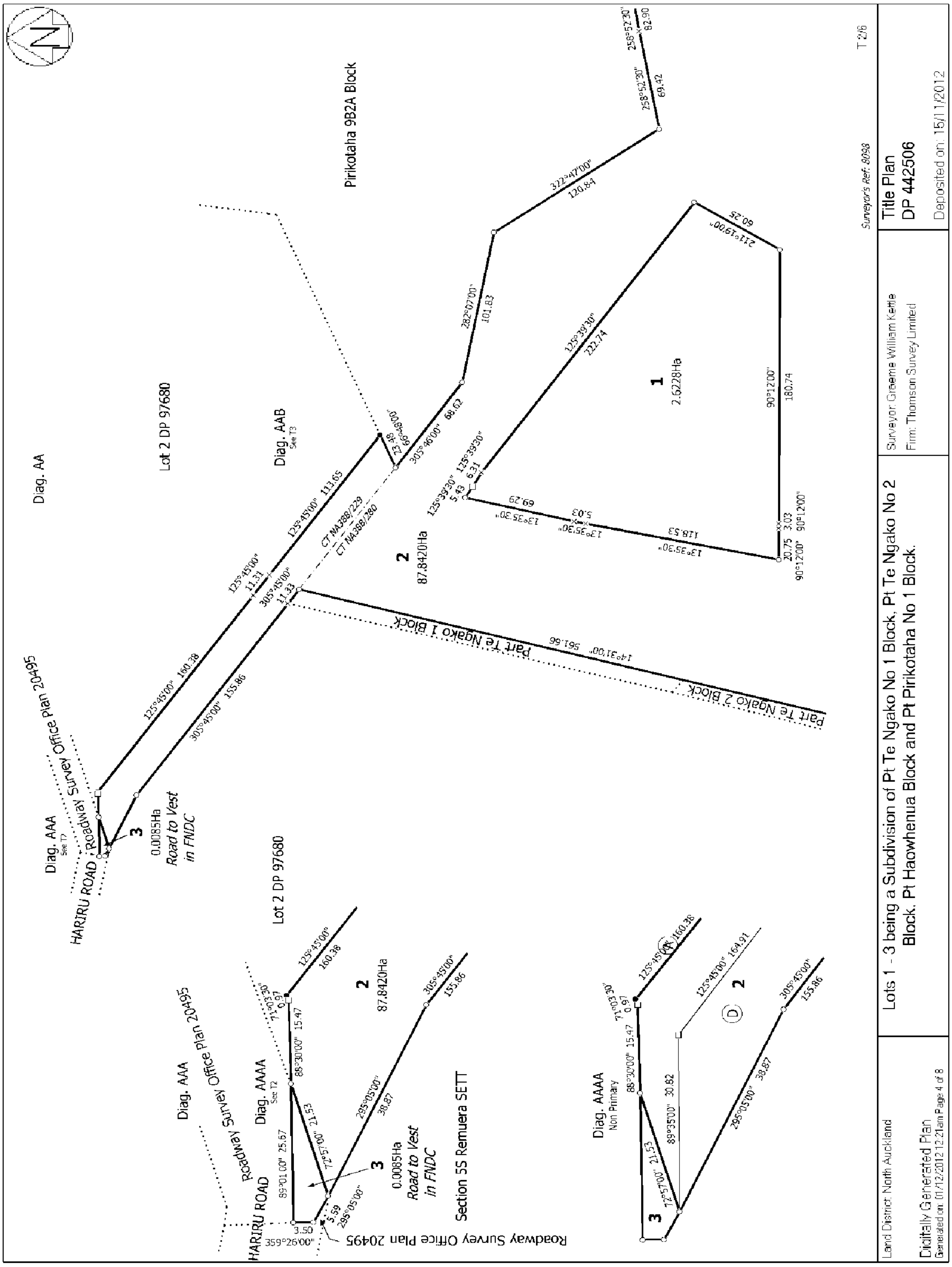
Title Plan
DP 442506
Deposited on: 15/11/2012

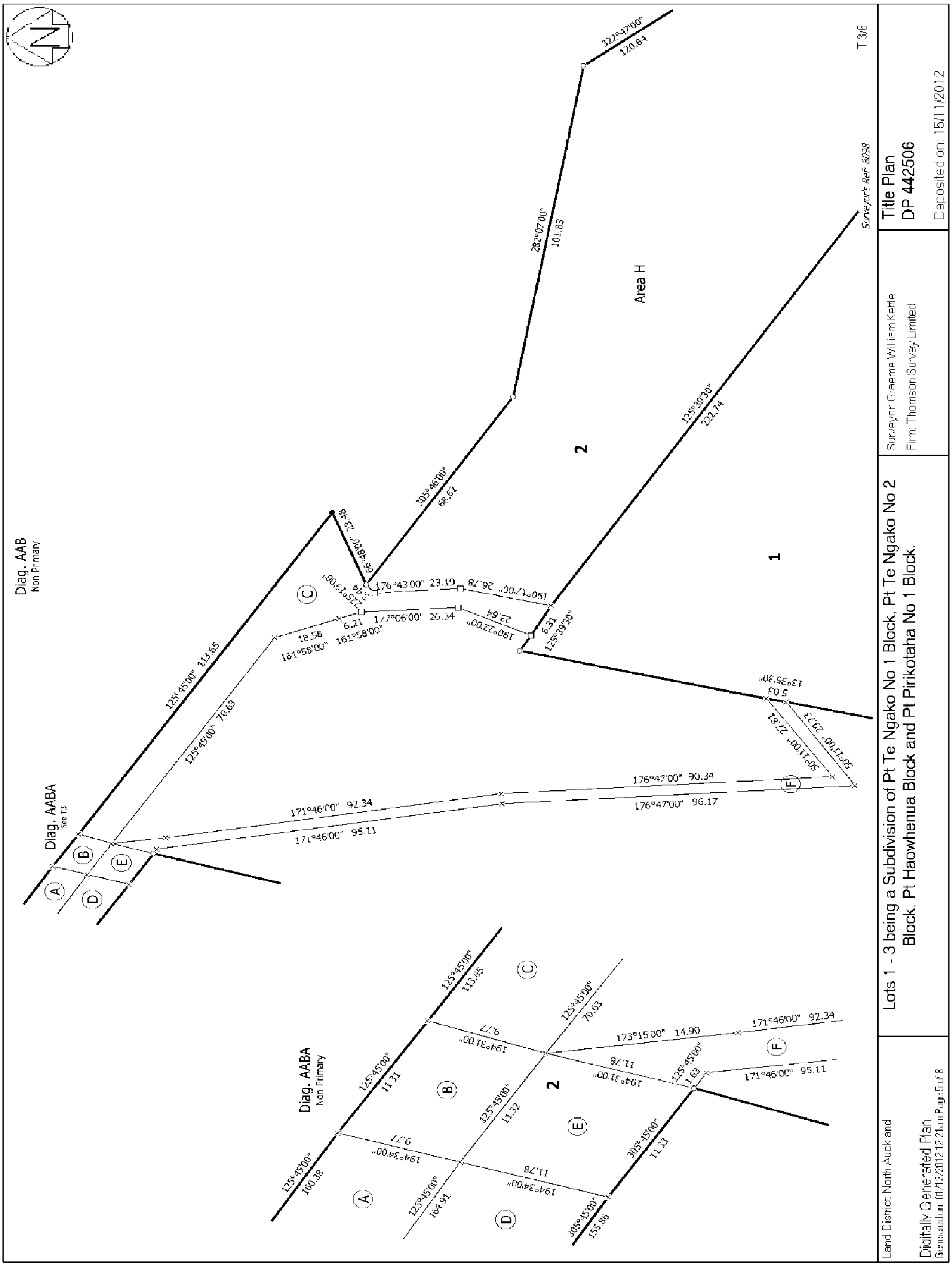
Surveyor: Greeme William Kettle
Firm: Thomson Survey Limited

Lots 1 - 3 being a Subdivision of Pt Te Ngako No 1 Block, Pt Te Ngako No 2 Block, Pt Haowhenua Block and Pt Pirikotaha No 1 Block.

Land District: North Auckland

Digitally Generated Plan
Generated on: 01/12/2012 12:21am Page 3 of 8


Lots 1 - 3 being a Subdivision of Pt Te Ngako No 1 Block, Pt Te Ngako No 2 Block, Pt Haowhenua Block and Pt Pirikotaha No 1 Block.
Land District: North Auckland
Digitally Generated Plan
Generated on: 01/12/2012 12:21am Page 4 of 8
Surveyor: Graeme William Kettle
Firm: Thomson Survey Limited
Title Plan
DP 442506
Deposited on: 15/11/2012
Surveyor's Ref: 8098
T 2/6
Pirikotaha 9B2A Block
Lot 2 DP 97680
Diag. AA
Diag. AAB
See T3
Diag. AAA
See T2
Diag. AAAA
Non Primary
HARIRU ROAD
Roadway Survey Office Plan 20495
1
2.6228Ha
2
87.8420Ha
3
0.0085Ha
Road to Vest in FNDC
Part Te Ngako 1 Block
Part Te Ngako 2 Block
CT NA388/229
CT NA388/280
Section 55 Remuera SETT
D
258°52'30" 82.90
258°52'30" 69.42
322°47'00" 120.84
282°07'00" 101.83
305°46'00" 68.62
23.48
69°48'00"
125°45'00" 113.65
125°45'00" 11.31
305°45'00" 11.33
125°45'00" 160.38
305°45'00" 155.86
125°39'30" 222.74
125°39'30" 6.31
125°39'30" 5.43
211°19'00" 60.25
90°12'00" 180.74
90°12'00" 3.03
90°12'00" 20.75
13°35'30" 69.29
13°35'30" 5.03
13°35'30" 118.53
141°31'00" 561.66
71°03'30" 0.97
88°30'00" 15.47
89°01'00" 25.67
72°57'00" 21.53
295°05'00" 38.87
295°05'00" 5.59
359°26'00" 3.50
89°35'00" 30.82
125°45'00" 164.91


Diag. AAB
Non Primary
Diag. AABA
See T3
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Non Primary
Area H
1
2
A
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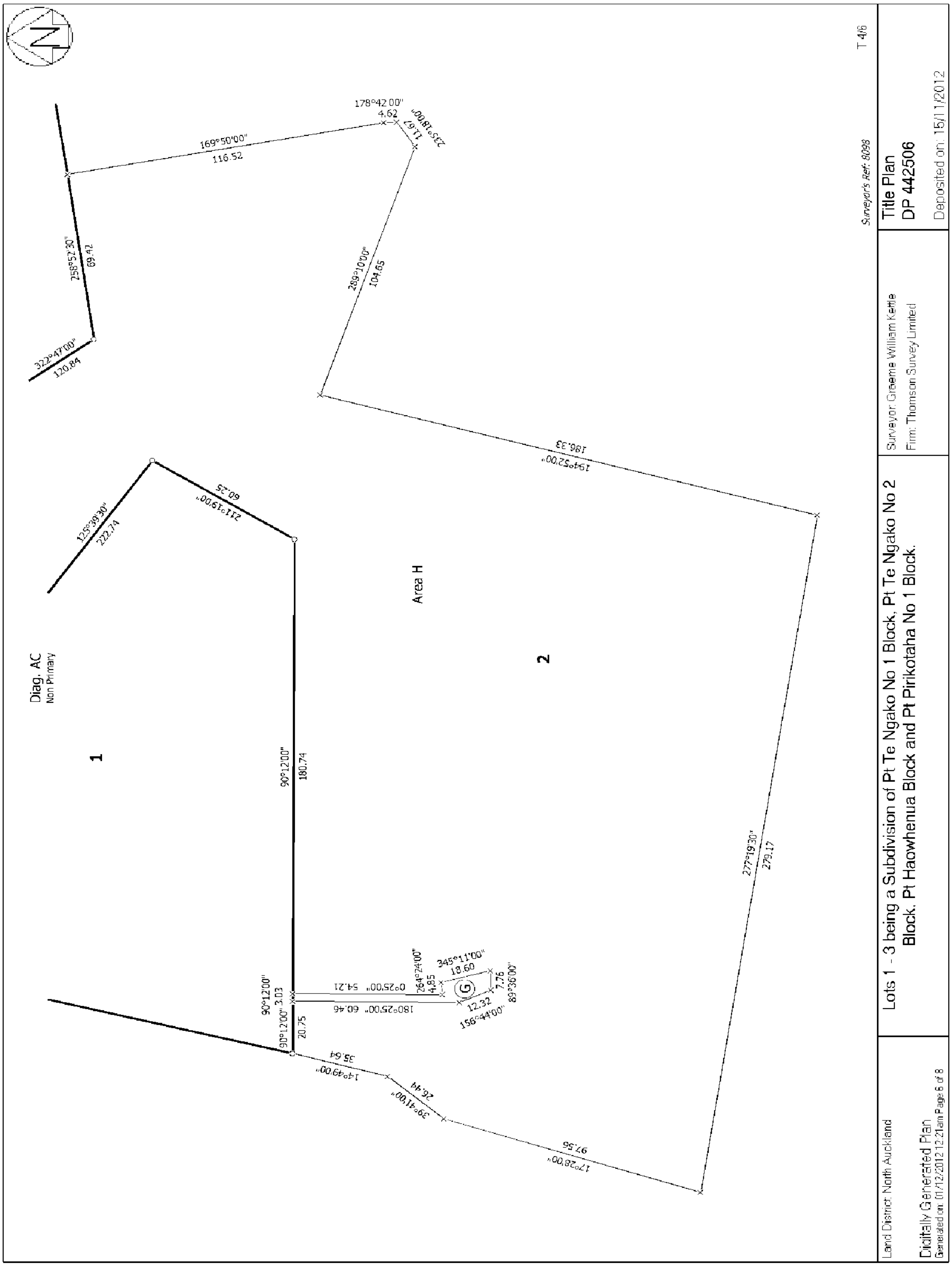
322°47'00" 120.84
282°07'00" 101.83
305°46'00" 68.62
125°39'30" 222.74
125°45'00" 113.65
125°45'00" 70.63
96°48'00" 22.48
176°43'00" 23.19
190°17'00" 26.78
177°06'00" 26.34
190°22'00" 23.64
18.58
161°58'00"
6.21
161°58'00"
6.31
125°39'30"
135°35'30"
5.03
50°11'00" 27.81
50°11'00" 29.73
176°47'00" 90.34
176°47'00" 96.17
171°46'00" 92.34
171°46'00" 95.11
125°45'00" 113.65
125°45'00" 11.31
125°45'00" 160.38
194°31'00" 9.77
194°34'00" 9.77
125°45'00" 70.63
125°45'00" 11.32
125°45'00" 164.91
173°15'00" 14.90
194°31'00" 11.78
194°34'00" 11.78
125°45'00" 1.63
305°45'00" 11.33
305°45'00" 155.86
T 3/6
Surveyor's Ref: 8098
Title Plan
DP 442506
Deposited on: 15/11/2012
Surveyor: Graeme William Kettle
Firm: Thomson Survey Limited
Lots 1 - 3 being a Subdivision of Pt Te Ngako No 1 Block, Pt Te Ngako No 2 Block. Pt Haowhenua Block and Pt Pirikotaha No 1 Block.
Land District: North Auckland
Digitally Generated Plan
Generated on: 01/12/2012 12:21am Page 5 of 8


N
178°42'00"
4.62
225°18'00"
11.67
169°50'00"
116.52
258°52'30"
69.42
322°47'00"
120.84
289°10'00"
104.65
186.33
194°52'00"
60.25
211°19'00"
125°39'30"
222.74
Area H
2
Diag. AC
Non Primary
1
90°12'00"
180.74
277°19'30"
279.17
264°24'00"
4.85
345°11'00"
18.60
7.76
89°36'00"
G
12.32
156°44'00"
0°25'00" 54.21
180°25'00" 60.46
90°12'00"
3.03
90°12'00"
20.75
35.64
149°49'00"
26.44
39°41'00"
97.56
172°28'00"
Surveyor's Ref: 8098
T 4/6
Title Plan
DP 442506
Deposited on: 15/11/2012
Surveyor: Greeme William Kettle
Firm: Thomson Survey Limited
Lots 1 - 3 being a Subdivision of Pt Te Ngako No 1 Block, Pt Te Ngako No 2 Block. Pt Haowhenua Block and Pt Pirikotaha No 1 Block.
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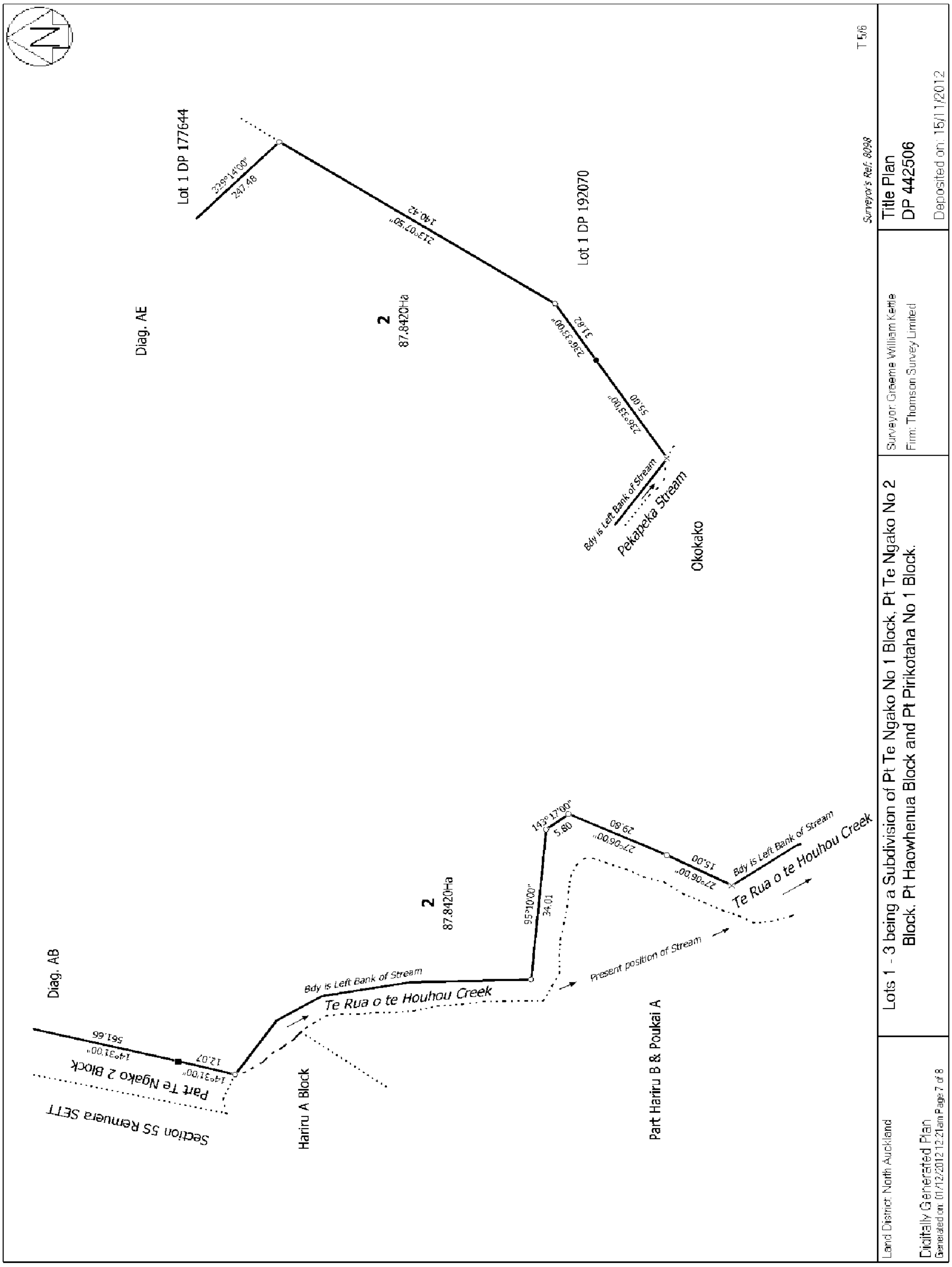
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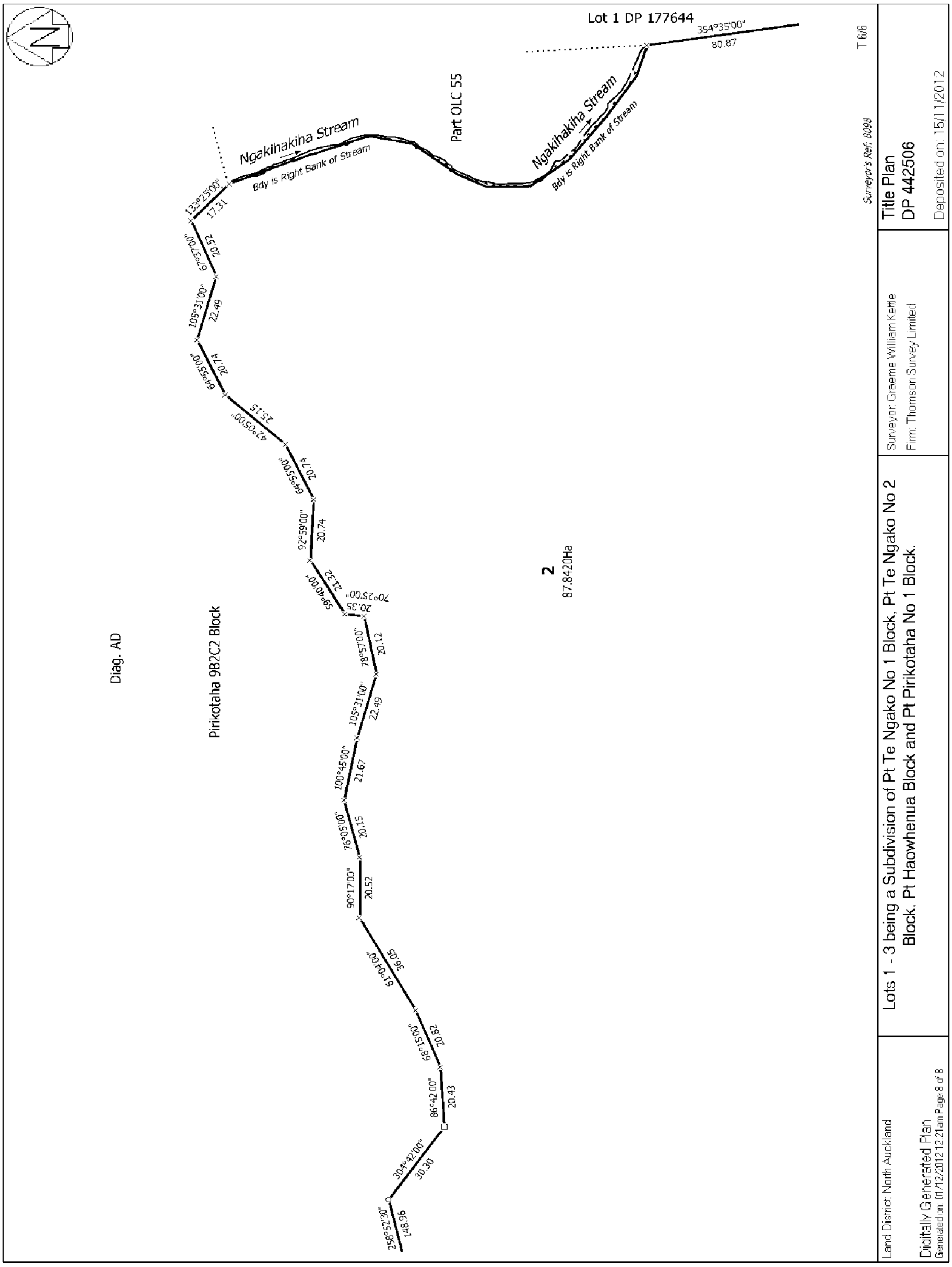
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Title Plan
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Deposited on: 15/11/2012
Surveyor: Greeme William Kettle
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RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD

Guaranteed Search Copy issued under Section 60 of the Land Transfer Act 2017

R.W. Muir
Registrar-General
of Land

Identifier **878815**
Land Registration District **North Auckland**
Date Issued 24 October 2019

Prior References
NA61D/332

Estate	Fee Simple
Area	22.4904 hectares more or less
Legal Description	Lot 5 Deposited Plan 533953

Registered Owners

Helen Sheila Bell as to a 1/2 share

Bruce Campbell Bell as to a 1/2 share

Interests

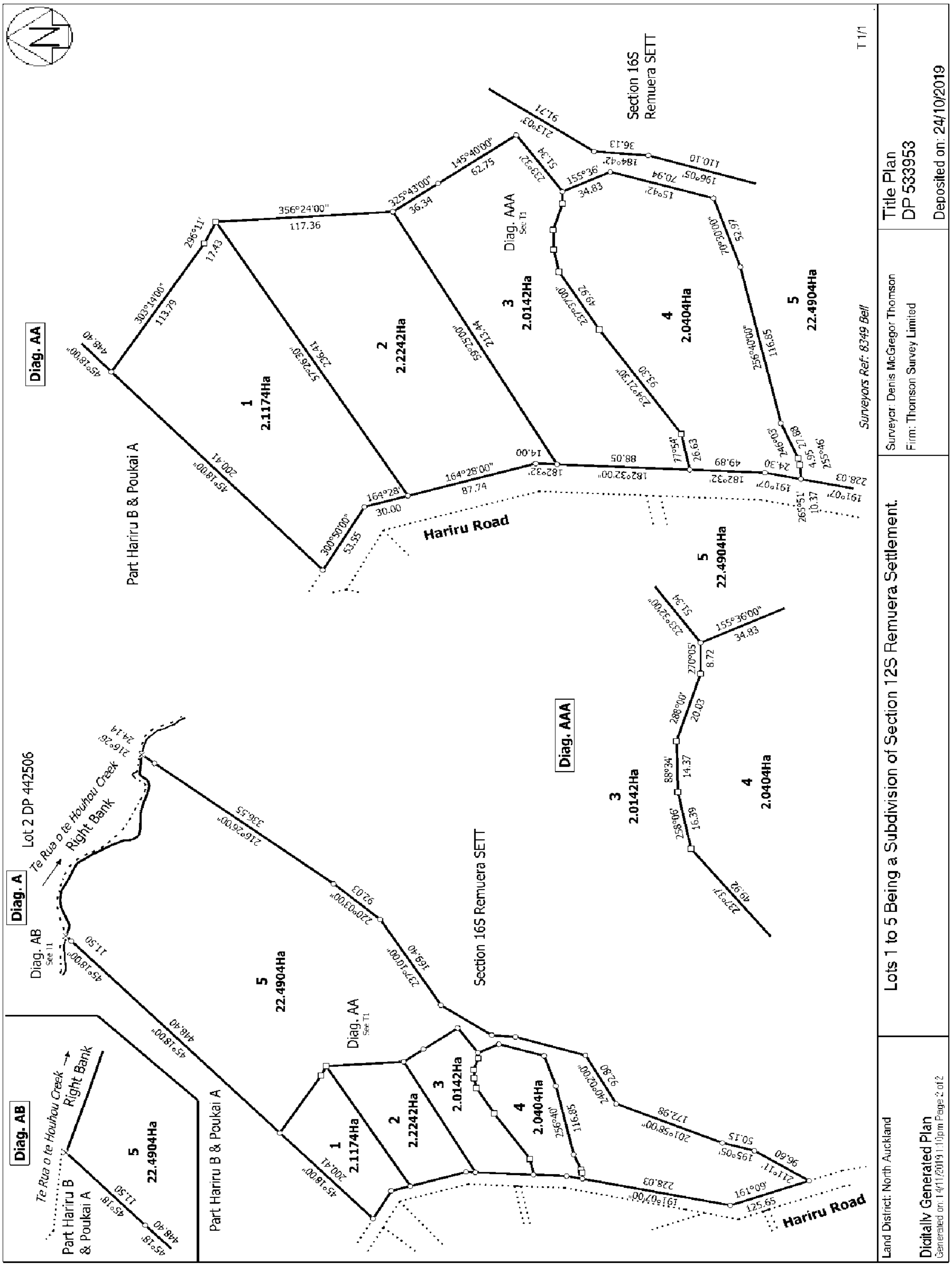
Subject to Section 59 Land Act 1948

Appurtenant hereto is a right to convey electricity and telecommunications created by Easement Instrument 11519443.5 - 24.10.2019 at 11:44 am

Land Covenant in Covenant Instrument 11519443.6 - 24.10.2019 at 11:44 am

Fencing Covenant created in Covenant Instrument 11519443.6 - 24.10.2019 at 11:44 am

Identifier **878815**



Appendix B. Records of Title

Consenting for Te Ruaotehauhau Stream Water Storage Reservoir

Hydrology Assessment

TE TAI TOKERAU WATER TRUST

WWLA0239 | Rev. 1

01 September 2020

Te Ruaotehauhau Stream Water Storage Reservoir Hydrology Study

Project no:	WWLA0239
Document title:	Te Ruaotehauhau Stream Water Storage Reservoir Hydrology Study
Revision:	1
Date:	01 September 2020
Client name:	Te Tai Tokerau Water Trust
Project manager:	Chris Frost
Author(s):	Josh Mawer
File name:	G:\My Drive\Projects\Te Tai Tokerau Water\Feasibility\MN06\06 Hydrology\Report_TRSWSR_Hydrology Study.docx

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Document history and status

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1	01 Sept 2020	First revision	Josh Mawer	Jon Williamson	Jon Williamson

Distribution of copies

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1	01 Sept 2020	Te Tai Tokerau Water Trust	First revision.

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1. Introduction

Williamson Water & Land Advisory (WWLA) supported by a wider consortium of experts was commissioned by the Te Tai Tokerau Water Trust in July 2020 to prepare technical reports and documentation required for resource consent for a proposed 1.4 Mm^3 water storage reservoir in the catchment of the Te Ruaotehauhau Stream. The reservoir is known as the Te Ruaotehauhau Stream Water Storage Reservoir (TRSWSR).

1.1 Background

The TRSWSR (previously referred to as MN-06) was identified as a potential water storage reservoir site through the Northland Water Storage and Use Project (NWSUP) Pre-Feasibility Demand Assessment and Design Study, undertaken by WWLA and other technical experts for Northland Regional Council (NRC) in August 2019 (WWLA, 2020 a, b, c). In June 2020, the project was transferred to the Te Tai Tokerau Water Trust, who commissioned advancement of the TRSWSR scheme with detailed design and consenting programmes instigated.

The wider scope of works, undertaken to support consenting of the reservoir, includes the following by the indicated specialists:

- Consent documentation (WWLA);
- Ecological Assessment (Puhoi Stour);
- Archaeological Assessment (Geometria);
- Landscape Assessment (Simon Cocker Landscape Architecture);
- Geotechnical Assessment and Reservoir Conceptual Design (Riley Consultants); and
- Hydrological Assessment (WWLA).

This technical report presents the hydrological analysis and details the assessment of environmental impacts and effects on downstream water users.

1.2 Report Structure

The report comprises descriptions of:

- A project overview (**Section 2**);
- A review of surface water allocation policy (**Section 3**);
- Catchment modelling overview (**Section 4**);
- Analysis of existing hydrological regimes and allocation (**Section 5**);
- Proposed storage reservoir and water takes (**Section 6**);
- Assessment of Environmental Effects (**Section 7**);
- Analysis of impacts on downstream water users (**Section 8**); and
- Summary and conclusions (**Section 9**).

2. Project Overview

2.1 Location

A location overview of the proposed 1.4 Mm^3 TRSWSR is displayed in **Figure 1**. The reservoir is positioned in the upper catchment of the Te Ruaotehauhau Stream, and will be used to service and support local horticultural operations.

Full details of the conceptual design of the reservoir itself are presented in RILEY (2020) *Geotechnical and Site Suitability Assessment Water Storage Reservoir, Ohaewai.*

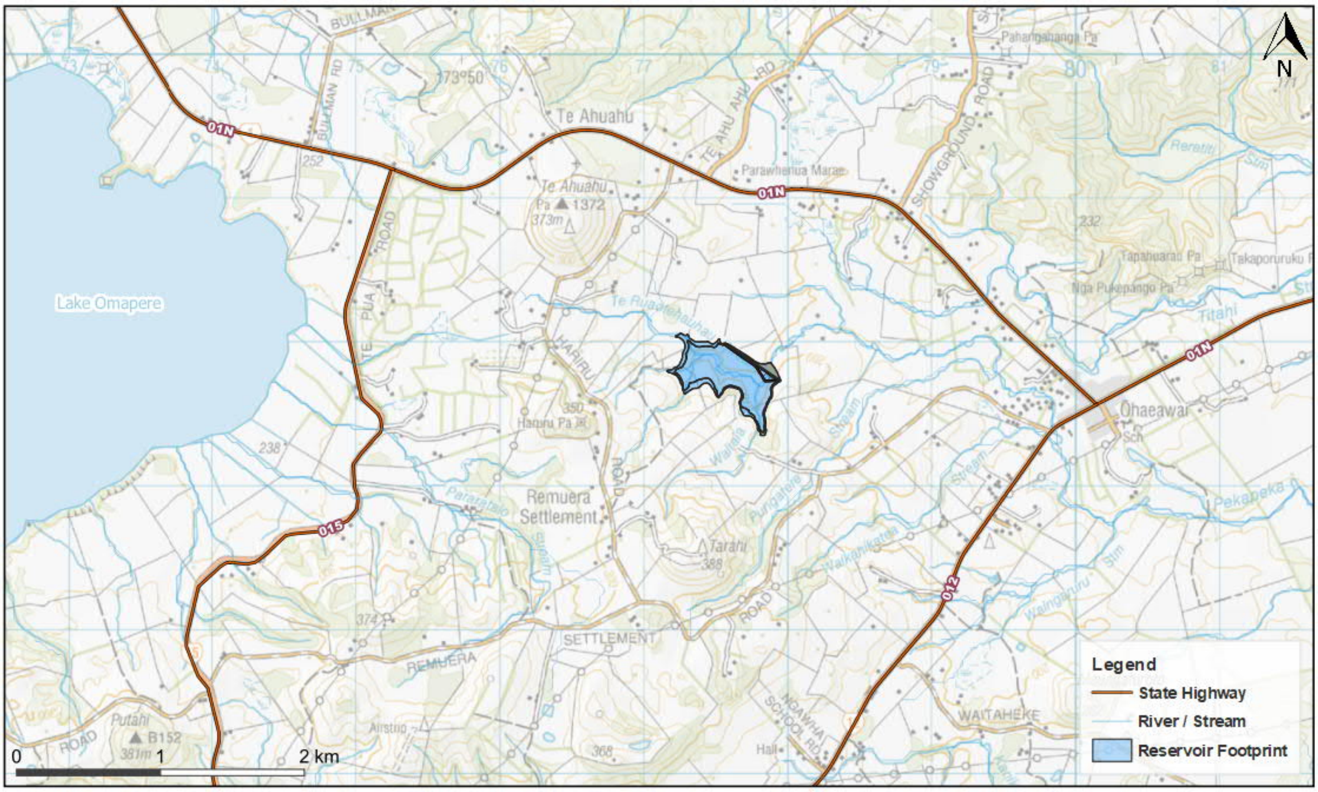


Figure 1. Project location overview map.

2.2 Water Resources

Stored water will arise from the following components:

- The reservoir will be filled through direct catchment inflows. A base flow will be maintained in the stream downgradient of the reservoir.
- It is currently proposed to harvest:
  - High flows above the median, up to two times the standard deviation of flow at all times they are available (and the reservoir is not full), and
  - Low flow core allocation outside of the irrigation season (i.e. winter months) only.

It should be noted, these water takes will be consented separately from the reservoir itself. Details of the two takes are summarised in **Table 1**.

Table 1. Proposed water takes.

Take type	**Rate (L/s)**	**Minimum flow criteria (L/s)**	**Note**
High-flow take	0 - 451	29	Gravity inflow from median to median plus 2x Std. Dev.
Core allocation / low-flow take	3.0	5.9	Gravity inflow during winter only

2.3 Water Use Requirements

The storage reservoir is proposed to service local community irrigation demands. Based on the NWSUP Pre-feasibility Design and Demand Study, the reservoir is expected to support up to approximately 390 hectares of horticultural development (WWLA, 2020 d. in prep). The total aera of land serviced will ultimately depend on community uptake.

This hydrology assessment has been undertaken on the assumption of a maximum daily demand of 16,160 m^3/day during the irrigation season.

3. Regulatory Framework

This section provides an overview of key policy regarding surface water allocation and takes from the Proposed Regional Plan Northland (PRPN).

3.1 Allocation Limits

Allocation limits for streams are set to protect the health of aquatic ecosystems by capping the amount of water that can be taken from a water body above a minimum flow or level for lakes. This enables natural fluctuations in stream flow to occur, while providing somewhat for security of supply. An allocation limit along with a minimum flow criterion is defined, with restrictions applying when stream flow reduces below the minimum flow rate.

3.1.1 Core Allocation / Low-flow

NRC grouped networks of streams into freshwater management units based on common values of the water bodies and the sensitivity of the values to change in flow as follows:

- Large River;
- Small River;
- Coastal River; and
- Outstanding Value River.

All rivers and streams of interest to this study are classified as small rivers, which implies minimum flow of 80% MALF and an allocation limit of 40% of the MALF are relevant (**Table 2**).

Policy H.4.3 of the Proposed Regional Plan for Northland states, the quantity of river flow available for abstraction below the median must not exceed the criteria outlined in **Table 2**, provided a minimum river flow is maintained (**Policy H.4.1**).

Table 2. Minimum flow criteria and allocation limits for Northland's rivers.

Management Unit	Minimum Flow (% of 7-day MALF)	Allocation Limit (% of 7-day MALF)
Outstanding rivers	100%	10%
Coastal rivers	90%	30%
Small rivers	80%	40%
Large river	80%	50%

3.1.2 High Flow

When river flow is above the median flow, **Policy C.5.1.10** states that the taking and use of water for a river that is not a permitted or controlled activity, is a restricted discretionary activity. Matters of discretion include:

1. The timing, rate and volume of the take to avoid or mitigate effects on existing authorised takes and aquatic ecosystem health.
2. Measures to ensure the reasonable and efficient use of water.
3. The positive effects of the activity.

4. Catchment Modelling

The following section details the catchment modelling undertaken to characterise the existing hydrological regime of the rivers and streams of interest.

The catchment model detailed in the sections below was based on the catchment model developed as part of the NWSUP: Pre-Feasibility, and further refined for this increased detail assessment and calibrated against newly available flow monitoring data.

Full details on the development of the original catchment model are provided WWLA (2020) NWSUP – Volume 2: Water Resources Analysis.

4.1 Available Data

The following sections summarise the available data used during the development of the catchment flow model relevant to the TRSWSR hydrology study.

4.1.1 Climate Data

The nearest rain gauge to TRSWSR from NRC’s rain gauge network is the Waitangi at Ohaeawai gauge, located approximately 1.5 kilometres to the south-east. This met station has fifteen-minute rainfall data covering the period from 25 June 1998 to present.

In order to provide a consistent method of supplying long-term (i.e. 1972 to present) rainfall and evaporation data to all sub-catchment in the catchment model (i.e. including sub-catchments where no rain gauges exist), the National Institute of Water and Atmospheric Research (NIWA) virtual climate station network (VCSN) data were used.

The VCSN data provides estimates of daily rainfall and potential evapotranspiration on a 5 km regular grid, covering all of New Zealand. Estimates of climate parameters are produced for each VCSN point on a daily time-step based on spatial and temporal interpolation of recorded observation data at the nearest reliable meteorological sites. A comparison of measured rainfall from NRC’s Waitangi at Ohaeawai gauge and the nearest VCSN station is provided in WWLA (2020b), and showed good agreement between the two datasets.

Given the relatively small spatial scale of interest, a single VCSN point (Station ID: 30694), located approximately three-kilometres northwest of the proposed TRSWSR, was used for the hydrology assessment. Average monthly rainfall and evaporation for this location are displayed in **Figure 2**.

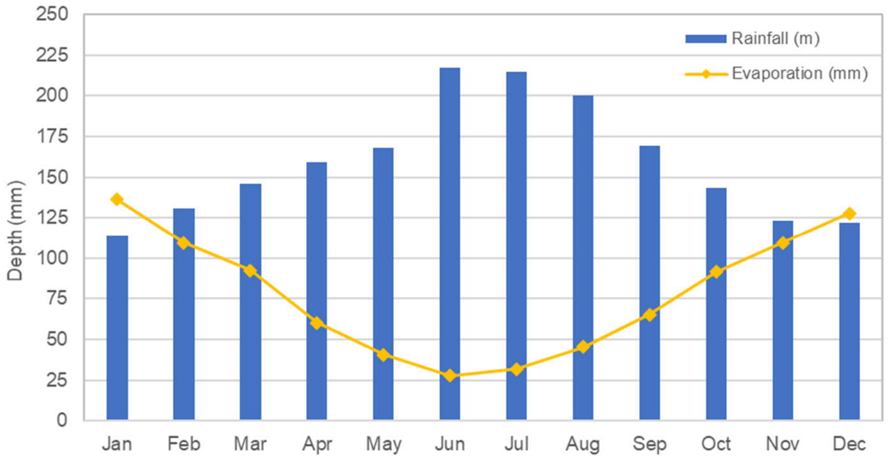


Figure 2. Average monthly rainfall and evaporation.

4.1.2 Flow Data

Observed flow data were available from two locations downstream of the TRSWSR. These are summarised in **Table 3** and there locations shown in **Figure 3**. The two monitoring sites were used to provide a degree of verification to the accuracy of simulated flows from the catchment model.

Table 3. Summary of available flow data.

Dataset	**Location Relative to TRSWSR**	**Description**	**Source**
Pungatere at Sheehan	Approx. 1.8 km downstream	1 spot gauging taken on 18/12/1991	NRC
Waiaruhe at SH1 Bridge	Approx. 9.1 km downstream	58 spot gaugings taken between 04/1978 and 03/2019	NRC

Figure 3. Location of available gauged flow data. (Refer A3 attachment at rear).

4.1.3 Consented Water Takes

A summary of consented water takes in close proximity to TRSWSR are displayed in **Table 4** and **Figure 4**. Of the four takes, two (highlighted in red) are located on the Te Ruaotehauhau Stream, downstream of the proposed reservoir. The remaining two are in neighbouring catchments, and therefore will not be impacted (either positively or negatively) by the reservoir.

Table 4. Consented water takes downstream of TRSWSR.

IRIS ID	**Source**	**Purpose**	**Annual Take per Year (m^3)**
AUT.017199.02.01	Dam Water	Irrigation - Horticulture	3,850
AUT.017199.01.02	Surface Water	Irrigation - Horticulture	7,150
AUT.017643.01.02	Surface Water	Irrigation - Horticulture	15,960
AUT.028688.01.02	Surface Water	Irrigation - Horticulture	28,800

Figure 4. Consented water takes downstream, or in close proximity to TRSWSR. (Refer A3 attachment at rear).

4.2 Soil Moisture Water Balance Model

In order to quantify the volume of water available for harvesting and storage, catchment models were developed for Te Ruaotehauhau Stream.

The following subsections describe the available data used in developing the catchment flow models and the development and calibration of these catchment flow models.

4.2.1 Overview

The Soil Moisture Water Balance Model (SMWBM) was utilised as the rainfall runoff model for this project. The SMWBM is a semi-deterministic model that is parameterised via relationships to catchment physical characteristics. Model functionality incorporates daily rainfall disaggregation and computation on an hourly timestep during rain events, interception storage, surface runoff, surface ponding, soil infiltration, soil moisture storage, sub-soil drainage, vadose zone flow and groundwater discharges for differing land physical characteristics and use types. The model also contains an irrigation demand module. The vadose zone and irrigation demand modules were not used in this assessment.

The SMWBM incorporates parameters characterising the catchment in relation to the following characteristics, with a conceptual diagram of the SMWBM structure and functionality described in more detail in **Appendix A**.

- Interception storage;
- Evaporation losses;
- Soil moisture storage;
- Surface runoff;
- Soil infiltration;
- Sub-soil drainage;
- Stream base flows; and
- The recession and/or attenuation of ground and surface water flow components.

4.3 Model Verification

The catchment models developed for NWSUP – Volume 2: Water Resources Assessment were utilised for this assessment. Full details of the catchment model development and initial calibration are provided in the NWSUP – Volume 2: Water Resources report (WWLA, 2020b).

The sub-sections below detail the model verification to available spot gauge data (Pungatere at Sheehan and Waiaruhe at SH1 bridge) within the catchment of the TRSWSR.

Flow monitoring is currently being undertaken in the Te Ruaotehauhau Stream, at the location of the reservoir wall. The catchment models will be further verified against the new data prior to submission of the water take consents associated with the reservoir.

4.3.1 Pungatere at Sheehan

A comparison of modelled and observed flow at the Pungatere at Sheehan monitoring site is presented in **Figure 5** and **Figure 6**, on a linear and log-y axis respectively. In general, there is good agreement to the single low-flow spot gauging. However, the lack of data points and absence of high flow measurements prevents firm conclusions from being made on model calibration at this location.

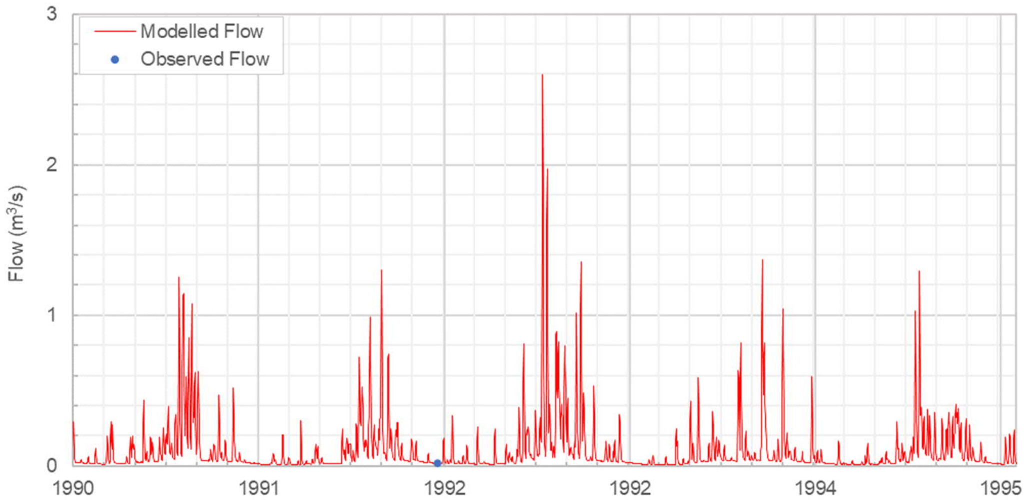


Figure 5. Comparison of modelled and observed flow at Pungatere at Sheehan.

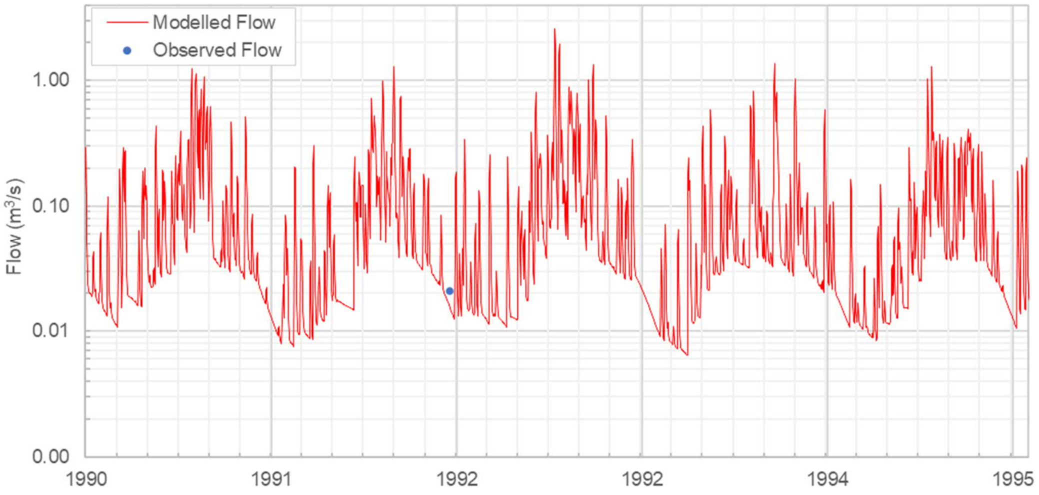


Figure 6. Comparison of modelled and observed flow at Pungatere at Sheehan on a logarithmic y-axis.

4.3.2 Waiaruhe at SH1 Bridge

A comparison of modelled and observed flow at the Waiaruhe at SH1 Bridge monitoring site is presented in **Figure 7** and **Figure 8**, on a linear and log-y axis respectively. In general, there is good agreement to the flow gaugings. The simulated flow demonstrated good agreement to available low and medium-high flow spot gauging data points.

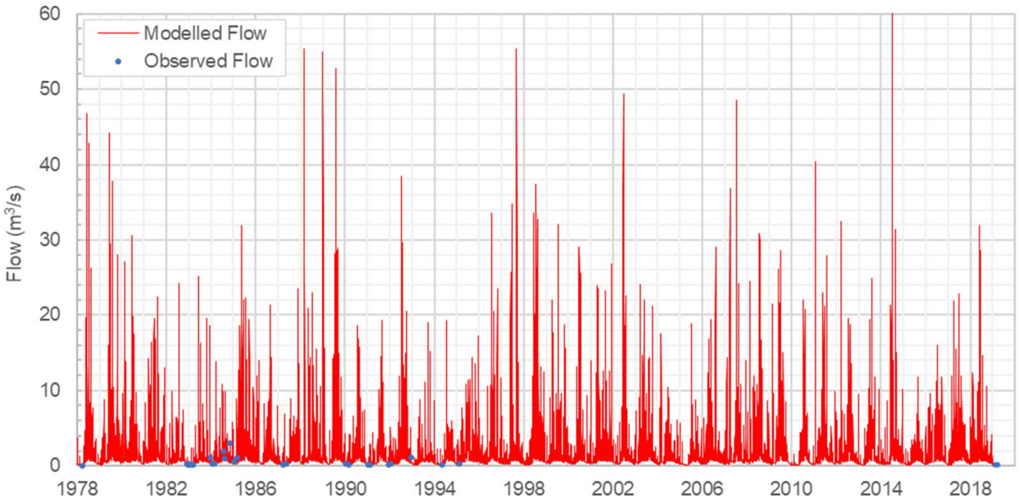


Figure 7. Comparison of modelled and observed flow at Waiaruhe at SH1 Bridge.

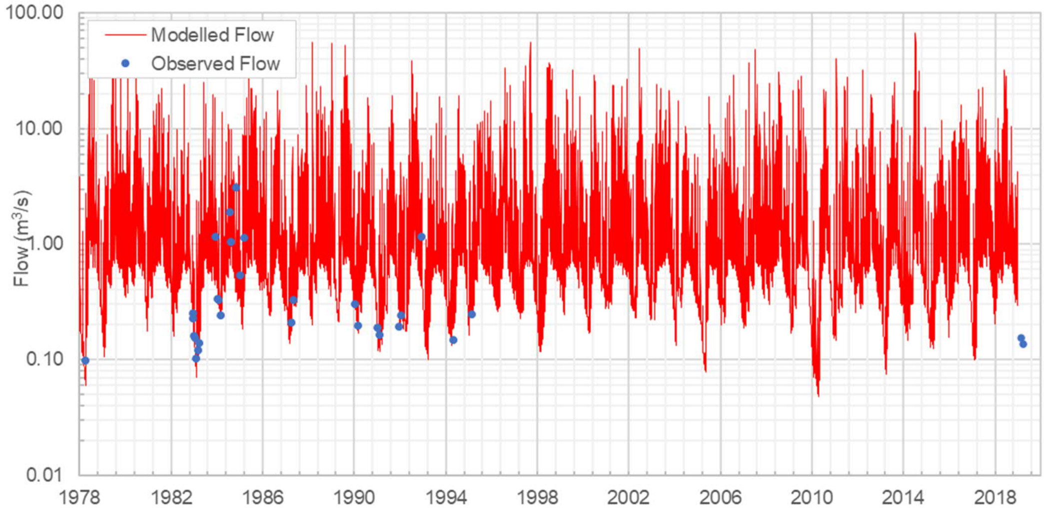


Figure 8. Comparison of modelled and observed flow at Waiaruhe at SH1 Bridge on a logarithmic y-axis.

4.3.3 Overall Statement on Model Verification

The catchment flow model is considered to have demonstrated good agreement to the available spot gauge data at Pungatere at Sheehan and Waiaruhe at SH1 Bridge. However, due to the lack of available flow gaugings, quantifiable model performance metrics (e.g. PBIAS and NSE) could not be calculated.

In addition, as the SMWBM simulates a closed water balance system, and there is good confidence in the rainfall input data (as described in WWLA, 2020b – Appendix B), this provides additional confidence in the overall volume of water simulated (groundwater + surface water) is held by the modelling team.

Overall, the model is considered to provide appropriate representation of daily streamflow dynamics for the purpose of this consent application. Flow monitoring data is currently being collected at the location of the reservoir wall and will be used to further verify the catchment model prior to submitting the water take consent application associated with the reservoir.

5. Existing Hydrological Regimes

The catchment models described in **Section 4** were used to simulate streamflow from 1972 to present at three representative reference locations in order to characterise the existing flow regimes of the Te Ruaotehauhau and Pekapeka Streams. A similar analysis is presented and compared in **Section 7.1** on flows simulated representing post construction of the reservoir and water takes.

The analysis includes the following component for each assessment location:

The analysis includes the following components for each assessment location:

- **Flow hydrographs and flow duration curves:** used to visually demonstrate change, along with standard statistics such as the 7-day mean annual low-flow (7-day MALF), and FRE3 (annual average number of flow events exceeding 3x the median flow).
- **The 7-Day MALF statistic:** is important as it forms the basis of low-flow allocation regulations under the PRPN, with the minimum flow criteria and allocable flow being defined as a proportion on the 7-Day MALF.
- **The FRE3 statistics:** is the number of floods per period of interest (year or season) greater than three times the relevant median flow. FRE3 provides an index of flow variability that is ecologically relevant i.e. the frequency of eco-system disturbance that is needed for a balanced ecosystem composition (periphyton, macro-invertebrates and other biota to co-habitat). Larger values of FRE3 are more desirable than smaller values.

5.1 Flow Assessment Locations

Three representative flow assessment locations were selected to compare the existing streamflow regime (this section) and post reservoir and streamflow take construction (**Section 7.1**). These locations are displayed in

Figure 9, and are described as follows:

- **Proposed TRSWSR Embankment Wall:** This assessment site represents the location immediately downstream of the TRSWSR embankment wall, and thus the location of greatest impact from harvest direct catchment inflows;
- **1,200 m Downstream of TRSWSR:** This assessment site represents the location 1,200 m downstream of the proposed reservoir Embankment wall; and
- **Downstream of Waikahikatea Confluence:** This assessment site represents the location immediately downstream of the Waikahikatea confluence.

Figure 9. Representative assessment locations and their catchments. (Refer A3 attachment at rear).

The existing flow regimes of these assessment locations are summarised in the sections below.

5.1.1 TRSWSR Embankment Wall

The hydrograph and flow duration curve for Te Ruaotehauhau Stream downstream of the embankment wall assessment location are presented in **Figure 10** and **Figure 11**, respectively and summary flow statistics are presented in **Table 5**.

Simulated historic streamflow at this location ranges from approximately 2.1 L/s to a maximum of 3,188 L/s, with a median of 28.9 L/s.

High flow events occur in response to rainfall events, while stream baseflow exhibits a seasonal pattern, with higher baseflow occurring during winter, and low-flows during summer.

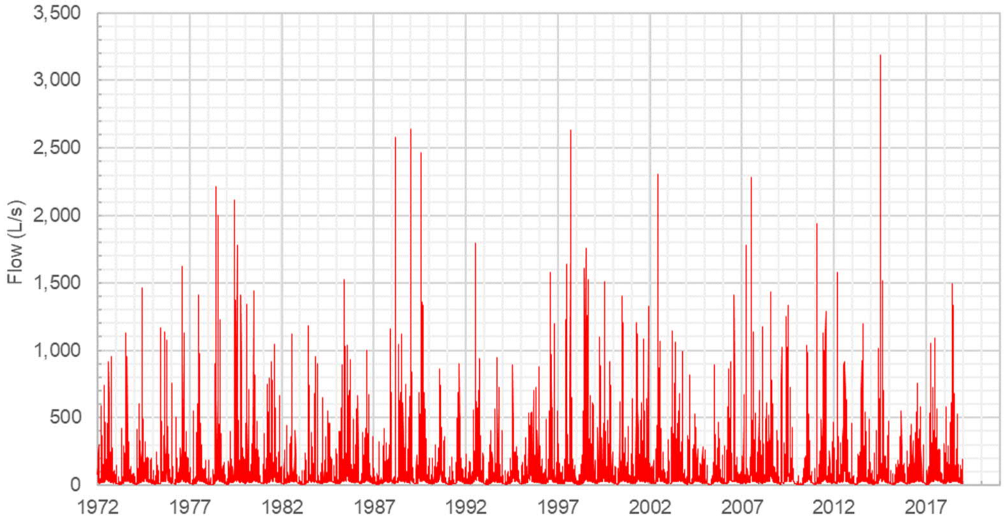


Figure 10. Simulated flow hydrograph for TRSWSR Embankment Wall assessment location.

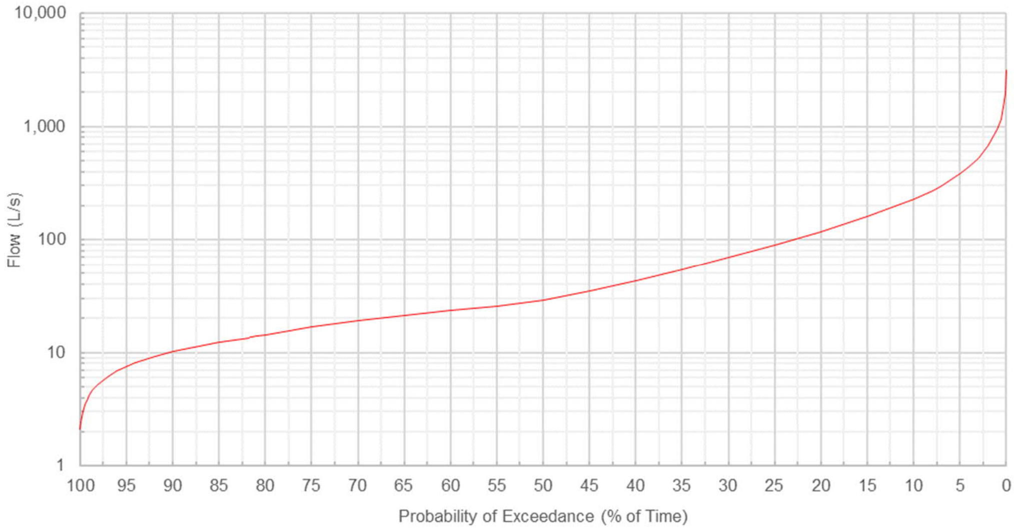


Figure 11. Simulated flow duration curve for TRSWSR Embankment Wall assessment location.

Table 5. Flow statistics for TRSWSR Embankment Wall assessment location.

Statistic	Value
Minimum (L/s)	2.1
Median (L/s)	28.9
Maximum (L/s)	3,188
7-Day MALF (L/s)	7.5
FRE3 (count)	22

5.1.2 1,200 m Downstream of TRSWSR

The hydrograph and flow duration curve for Te Ruaotehauhau Stream at the 1,200 m downstream of TRSWSR assessment location are presented in **Figure 12** and **Figure 13**, respectively, and summary flow statistics presented in **Table 6**.

Simulated historic streamflow at this location ranged from 2.8 L/s to 4,287 L/s, with a median flow of 38.8 L/s.

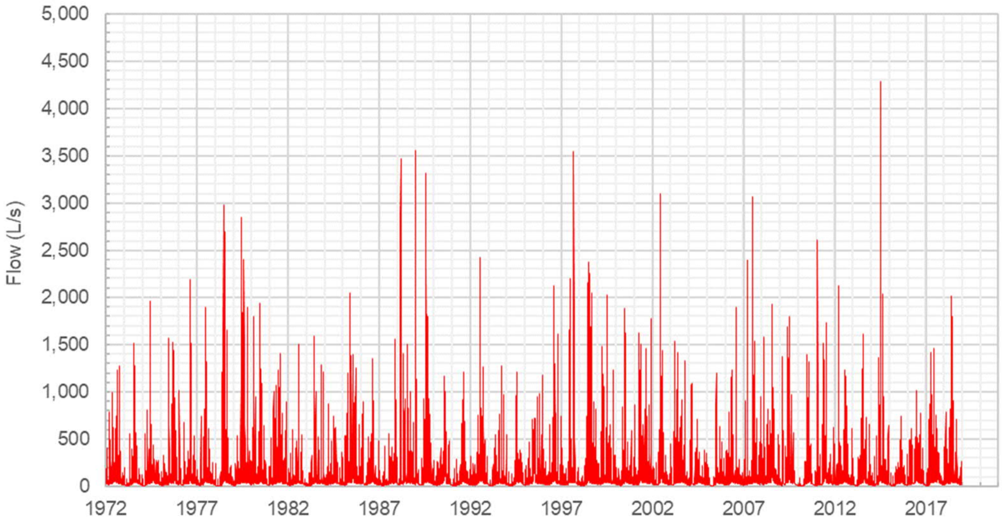


Figure 12. Simulated flow hydrograph for 1,200 m Downstream of TRSWSR assessment location.

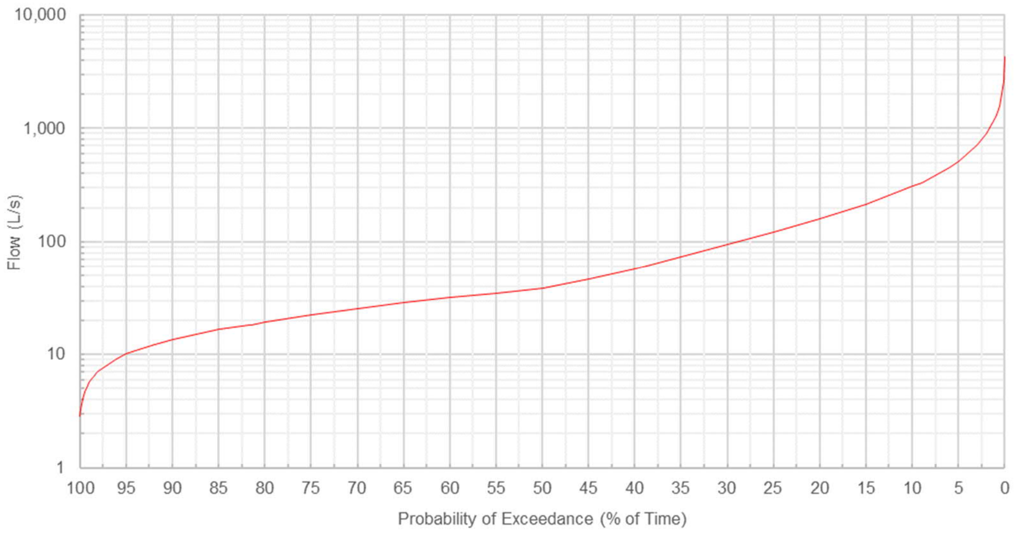


Figure 13. Simulated flow duration curve for 1,200 m Downstream of TRSWSR assessment location.

Table 6. Flow statistics for 1,200 m Downstream of TRSWSR assessment location.

Statistic	Value
Minimum (L/s)	2.8
Median (L/s)	38.8
Maximum (L/s)	4,287
7-Day MALF (L/s)	10.1
FRE3 (count)	22

5.1.3 Downstream of Waikahikatea Confluence

The hydrograph and flow duration curve for the Downstream of Waikahikatea Confluence assessment location are presented in **Figure 14** and **Figure 15**, respectively, and summary flow statistics presented in **Table 7**.

Simulated historic streamflow at this location ranged from 5.3 L/s to 7,998 L/s with a median flow of 72.4 L/s.

Streamflow at this location is approximately twice that of the upstream assessment location, owing to the larger catchment areas associated with the Pungatere Stream and Waikahikatea Stream that enter upstream of this assessment location.

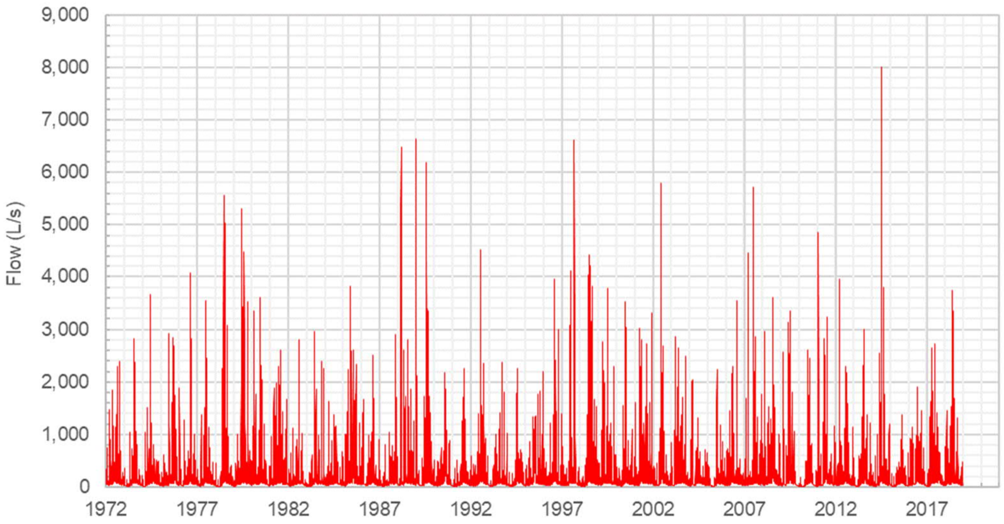


Figure 14. Simulated flow hydrograph for Downstream of Waikahikatea Confluence assessment location.

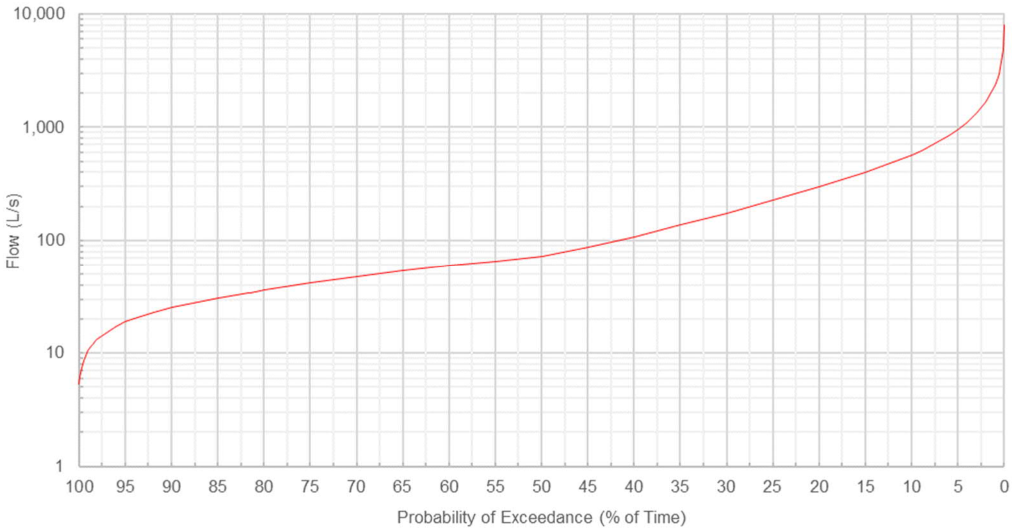


Figure 15. Simulated flow duration curve for Downstream of Waikahikatea Confluence assessment location.

Table 7. Flow statistics for Downstream of Waikahikatea Confluence assessment location.

Statistic	Value
Minimum (L/s)	5.3
Median (L/s)	72.4
Maximum (L/s)	7,998
7-Day MALF (L/s)	18.8
FRE3 (count)	22

5.2 Flow Regime Summary

A summary of daily average flow statistics along with key water take consenting metrics for each of the assessment sites are presented in **Table 8**.

Table 8. Summary of existing daily average flow regime statistics for key assessment locations.

Statistic	**TRSWSR Embankment**	**1,200 m Downstream TRSWSR**	**Downstream of Waikahikatea Confluence**
Catchment Area (km^2) [ha]	3.0 [301]	4.1 [408]	7.6 [762]
Minimum (L/s)	2.1	2.8	5.3
Median (L/s)	28.9	38.8	72.4
Maximum (L/s)	3,187	4,287	7,998
7-Day MALF (L/s)	7.5	10.1	18.8
Minimum Flow Criteria (80% MALF)	6.0	8.3	15.0
Run of River Allocation Limit (40% MALF)	3.0	4.0	7.5
FRE3 (count)	22	22	22

6. Proposed Storage Reservoir

Full details of the conceptual design of the reservoir itself are provided in RILEY (2020) *Geotechnical and Site Suitability Assessment Water Storage Reservoir, Ohaewai.* The design of reservoir is shown **Figure 16**, with key physical dimensions summarised in **Table 9**.

Figure 16. Reservoir design drawing. (Refer A3 attachment at Rear).

Table 9. Reservoir characteristics.

Property	Value
Dam crest Level (m)	207 m RL
Fully supply level (m)	205 m RL
Storage at full supply level (m^3)	1,400,000
Max. water depth at full supply (m)	17
Emergency spillway width (m)	40 (at base)

7. Assessment of Environmental Effects

The following sections detail the assessment of hydrological environmental impacts associated operation of the proposed TRSWSR water storage reservoir on downstream surface water flow regimes.

7.1 Impacts on Surface Water Flow Regimes

The impacts on surface water flow regimes were characterised by comparing a simulation of the existing flow regime (**Section 5**) with the flow regime post completion of the reservoir at the three representative flow assessment locations (**Section 5.1**).

7.1.1 Reservoir Operation

The conceptualised historic operation of the storage reservoir is presented in **Figure 17**, in regards to key inflow and outflow volumes, and changes in reservoir storage. The impact of these takes and release on the downstream flow regime at the three representative locations are then discussed in the sections below.

Figure 17. Reservoir operation – change in storage volume (top), and storage inflows and releases (bottom).

7.1.2 TRSWSR Embankment Wall

Comparisons of the flow duration curve and flow hydrograph under natural flow (simulated existing regime) and flow with the reservoir present are presented in **Figure 18** and **Figure 19**, respectively. As this location is immediately downstream of the reservoir, it represents the location of largest impact due to the storage of above median direct catchment inflows.

As indicated in **Figure 18**, a significant proportion of high flow is captured (harvested) by the reservoir. This has the effect of reducing high flow variability and frequency of flushing flows immediately downstream of the reservoir. The frequency of spills, or flushing flows from the reservoir will largely depend on the management regime and weather systems (i.e. back to back high flows during winter when the reservoir is full).

As demonstrated by the next downstream representative assessment location (**Section 0**), the proportional change in flow regime quickly diminishes with increasing distance downstream, as lateral catchment inflows increase and additional tributaries join the Te Ruaotehauhau Stream.

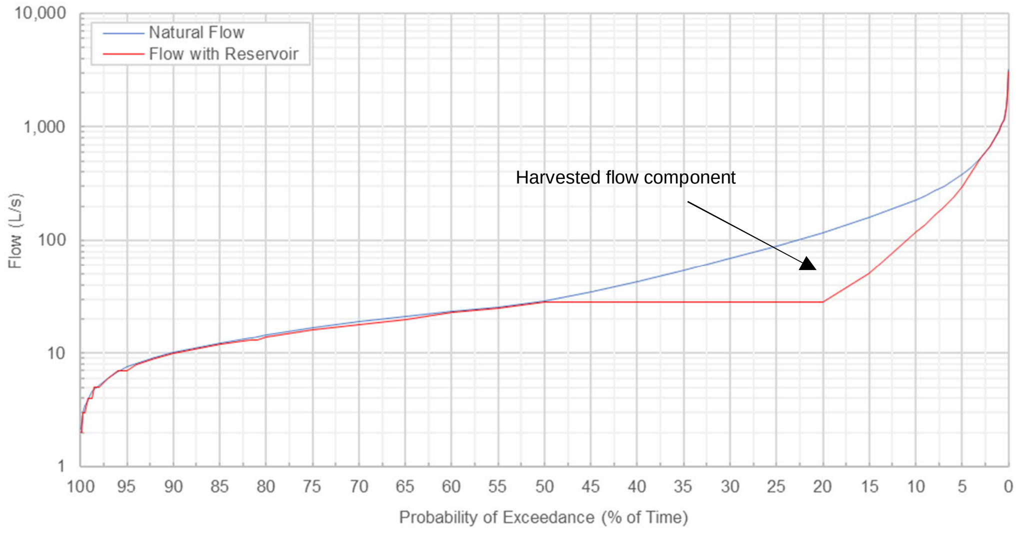


Figure 18. Comparison flow duration curve at the TRSWSR Embankment Wall assessment location.

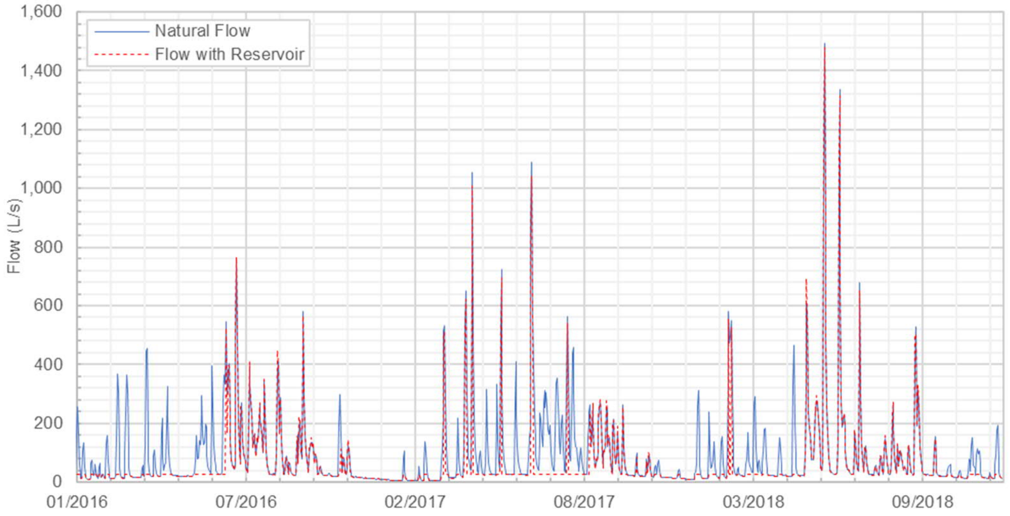


Figure 19. Example sub-set comparison of flow hydrographs at the TRSWSR Embankment Wall assessment location.

A comparison of the flow statistics between the two scenarios is presented in **Table 10**.

Table 10. TRSWSR Embankment Wall assessment location flow statistics.

Statistic	Natural Flow	Flow with Reservoir
Minimum (L/s)	2.1	2.0
Median (L/s)	28.9	25.0
Maximum (L/s)	3,188	3,051
7-Day MALF (L/s)	7.5	7.1
FRE3 (count)	22	12

7.1.3 1,200 m Downstream TRSWSR

Comparisons of the flow hydrograph and flow duration curve under natural flow (simulated existing regime) and flow with the reservoir present, at 1,200 m downstream of the TRSWSR reservoir, are presented in **Figure 20** and **Figure 21**, respectively. The impact of capturing above high flows in the reservoir as a proportion of total flow at this location has further reduced in comparison to upstream location.

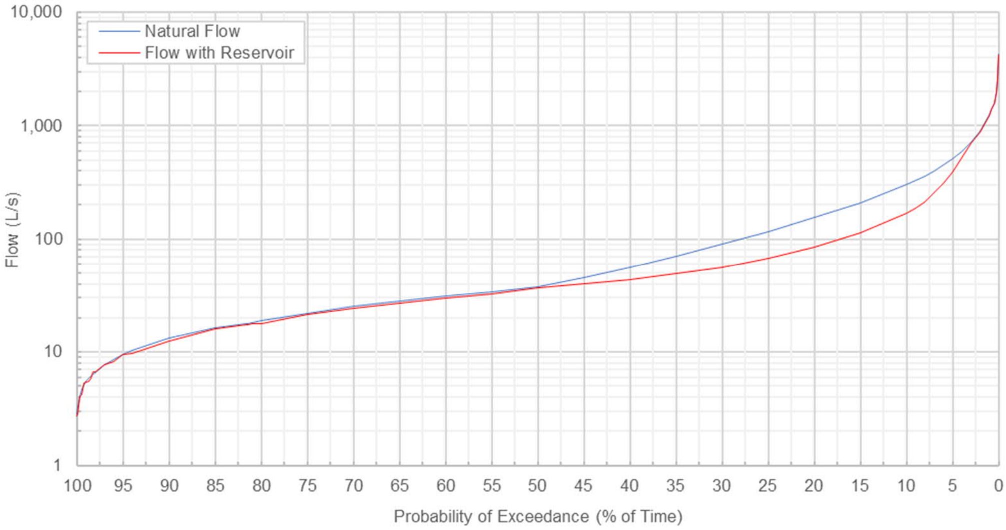


Figure 20. Comparison flow duration curve at the 1,200 m Downstream TRSWSR assessment location.

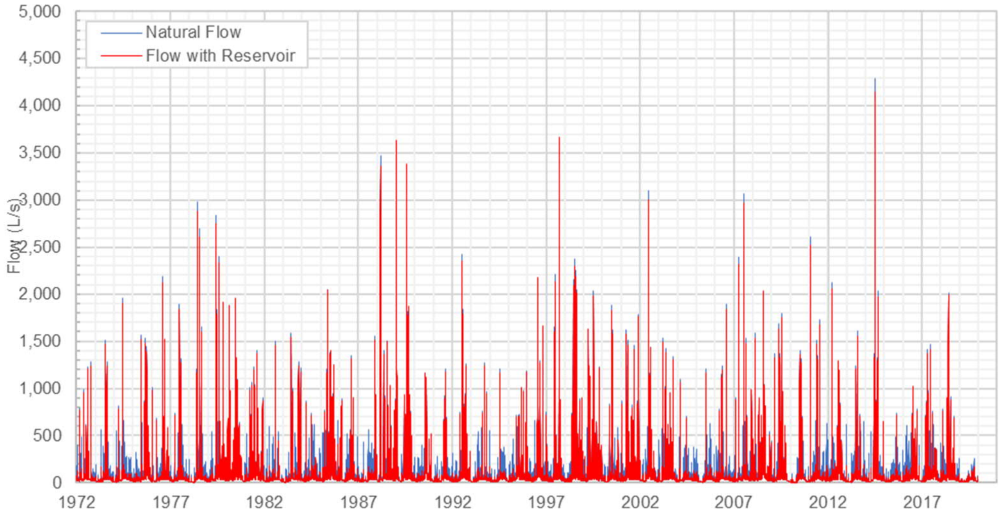


Figure 21. Comparison of flow hydrographs at the 1,200 m Downstream TRSWSR assessment location.

A comparison of the flow statistics between the two scenarios is presented in **Table 10**.

Table 11. 1,200 m Downstream TRSWSR assessment location flow statistics.

Statistic	Natural Flow	Flow with Reservoir
Minimum (L/s)	2.8	2.7
Median (L/s)	38.8	35.5
Maximum (L/s)	4,287	4,151
7-Day MALF (L/s)	10.1	9.8
FRE3 (count)	22	15

7.1.4 Downstream Waikahikatea Confluence

Comparisons of the flow hydrograph and flow duration curve under natural flow (simulated existing regime) and flow with the reservoir present, at one kilometre downstream of the reservoir, are presented in **Figure 22** and **Figure 23**, respectively. The impact of capturing high flows in the reservoir is minimal at this location as demonstrated by a small change in the FRE3 value from 22 to 19 with the reservoir.

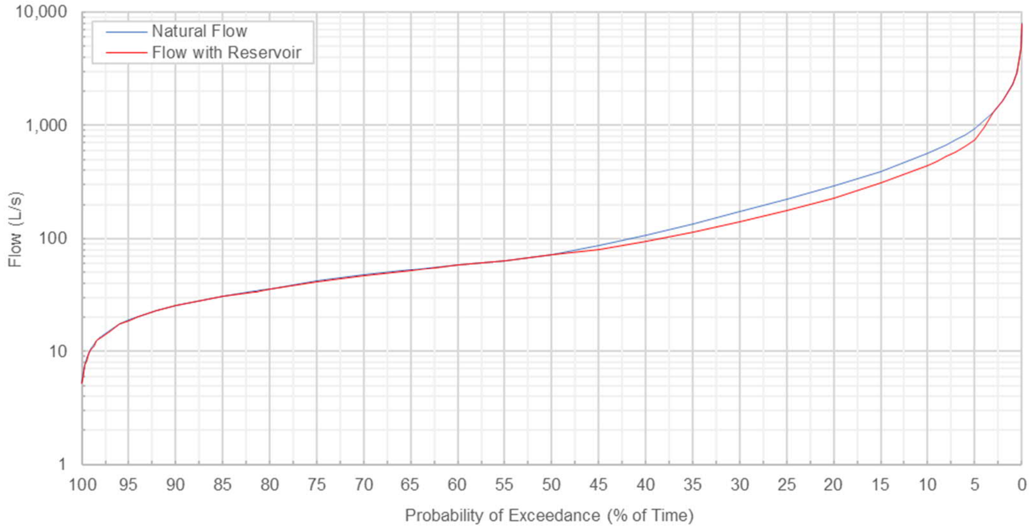


Figure 22. Comparison flow duration curve at the Downstream Waikahikatea Confluence assessment location.

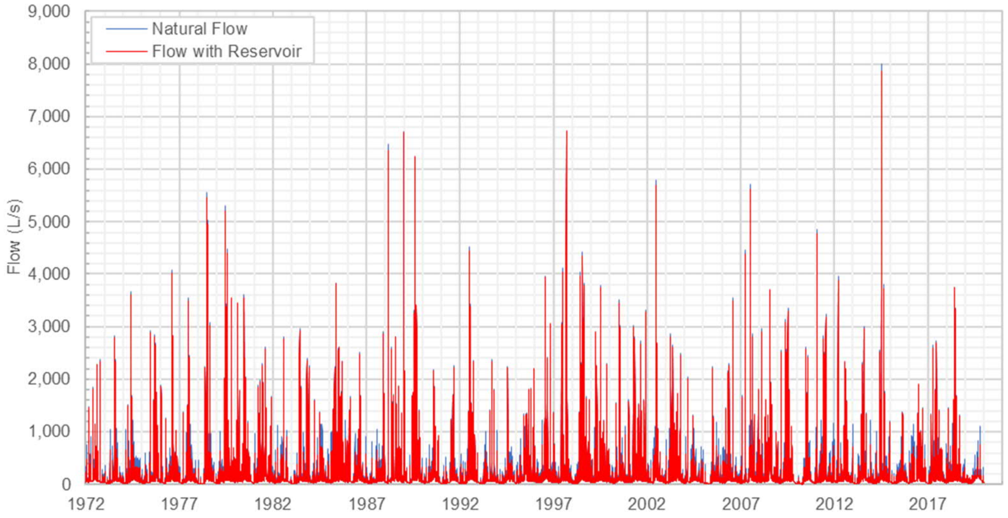


Figure 23. Comparison of flow hydrographs at the Downstream Waikahikatea Confluence assessment location.

A comparison of the flow statistics between the two scenarios is presented in **Table 10**.

Table 12. Downstream Waikahikatea Confluence assessment location flow statistics.

Statistic	Natural Flow	Flow with Reservoir
Minimum (L/s)	5.3	5.2
Median (L/s)	72.4	69.7
Maximum (L/s)	7,998	7,861
7-Day MALF (L/s)	18.8	18.7
FRE3 (count)	22	20

7.2 Impacts on Interactions with Groundwater

The reservoir may cause a small localised rise in groundwater levels due to reservoir seepage. If so, this would be considered to have a positive environmental impact, as it would act to increase stream baseflow. While this positive environmental impact is identified, such impacts are still considered to be minor.

8. Impact on Downstream Water Users

The following sections provide detail on the potential effect on downstream water users associated with the presence and operation of the proposed TRSWSR only, and does not detail those associated with proposed pumped water takes, as these are to be consented separately.

There are two currently consented surface water take downstream of the proposed reservoir (**Figure 4** and **Table 13**). The purpose of these consents is listed as "to take water for pasture irrigation". No other consented surface water takes occur downstream until directly before the outlet to the ocean.

Table 13. Consented water takes downstream of TRSWSR.

Consent Number	Purpose	Max. Rate (L/s)	Annual Allocation (m^3/yr)
AUT.017199.01.02	Irrigation	2.08	7,150
AUT.028688.01.02	Irrigation	3.33	28,800

8.1 Impact of Core Allocation (Low-flow) Take

The proposed core allocation take for direct inflows to the reservoir will only occur during winter. As the downstream consented takes (**Table 13**) are for irrigation of pasture, the consents would only be utilised during summer. Therefore, it is considered there will be no effect on downstream consented water takes associated with a winter core allocation take for direct inflows to TRSWSR.

8.2 Impact of High-Flow Take

The harvesting of high flows will not negatively affect the downstream consented water take. The reservoir high flow take will only occur during times of above median flow at the reservoir (> 29 L/s), and therefore, there will be at least 23.6 L/s in excess of the consented take rate passing downstream of the reservoir during periods of high flow harvesting. In addition, the consented irrigation take is not likely to be operational during times of high-flow taking (i.e. wet periods).

In terms of takes permitted under a Regional Plan or by Section 14(3)(b) of the Resource Management Act 1991, total daily take per property downstream of the lowest point of proposed taking is estimated at:

a) 10 cubic meters (equivalent to 0.116 L/s), or

b) 30 cubic metres (equivalent to 0.347 L/s) for the purposes of dairy shed wash down and milk cooling water,

Flows below the median (up to 28 L/s) will not be harvested and will bypass the reservoir. Therefore, significant water remains available for permitted takes during periods of high flow harvesting. The median flow of 29 L/s at the location immediately downstream of TRSWSR embankment is equivalent to 250 permitted takes at 0.116 L/s, or 83 permitted takes at 0.347 L/s. In addition, catchment flow increases with increasing distance downstream as additional lateral inflows occur and tributaries join.

Based on the above, the potential negative impacts on downstream water users are considered to be no more than minor.

9. Summary

This hydrology study considered the hydrological impacts of:

- the operation of the proposed TRSWSR;
- harvesting of high flow direct catchment inflows into the reservoir, from the median up to two times the standard deviation of flow;
- a core allocation (low-flow) take of direct catchment inflows, during winter only.

The following key conclusions were drawn from the hydrology study:

- The largest impact on streamflow in Te Ruaotehauhau Stream is directly downstream of the reservoir due to the capture of above median flows within the reservoir upstream. As all below median flow is bypassed, there is no change in streamflow during periods of below median flow (50% of the time). During winter there will be a small reduction (3.0 L/s) due to the core allocation take.
- The change in streamflow as a proportion of the total flow, due to upgradient capture of direct inflows, decreases with increasing distance downstream of the reservoir as lateral catchment inflows occur and additional tributaries join. The general variation in streamflow is largely similar to the simulated natural streamflow regime at the Waikahikatea Confluence assessment location.
- There are two consented water takes downstream of TRSWSR, both for pasture irrigation. These consented takes will not be negatively impacted by the proposed winter core allocation, or the high flow take.

10. References

Clausen, B., Biggs, B.J.F. 1997. Relationships between benthic biota and hydrological indices in New Zealand streams. Freshwater Biology 38, 327-342

RILEY. 2020 *Geotechnical and Site Suitability Assessment MN06 Water Storage Reservoir, Ohaewai.* RILEY Report Reference 190416-A.

WWLA. 2020a. Northland Water Storage and Use Project – Volume 1: Command Area Refinement and Analysis. Consultancy Report prepared for Northland Regional Council by Williamson Water & Land Advisory.

WWLA. 2020b. Northland Water Storage and Use Project – Volume 2: Water Resources Assessment. Consultancy Report prepared for Northland Regional Council by Williamson Water & Land Advisory and RILEY Consultants.

WWLA. 2020c. Northland Water Storage and Use Project – Volume 3: Conceptual Design and Costing. Consultancy Report prepared for Northland Regional Council by Williamson Water & Land Advisory and RILEY Consultants.

WWLA. 2020d. Northland Water Storage and Use Project – Kaipara Optimisation Study. Consultancy Report prepared for Te Tai Tokerau Water by Williamson Water & Land Advisory and RILEY Consultants.

Appendix A. SMWBM Parameters

Parameter	Name	Description	Calibrated Value
ST (mm)	Maximum soil water content	ST defines the size of the soil moisture store in terms of a depth of water.	448
SL (mm)	Soil moisture content where drainage ceases.	Soil moisture storage capacity below which sub-soil drainage ceases due to soil moisture retention.	0
FT (mm/day)	Sub-soil drainage rate from soil moisture storage at full capacity	Together with POW, FT (mm/day) controls the rate of percolation to the underlying aquifer system from the soil moisture storage zone. FT is the maximum rate of percolation through the soil zone.	0.5
ZMAX (mm/hr)	Maximum infiltration rate	ZMAX and ZMIN are nominal maximum and minimum infiltration rates in mm/hr used by the model to calculate the actual infiltration rate ZACT. ZMAX and ZMIN regulate the volume of water entering soil moisture storage and the resulting surface runoff. ZACT may be greater than ZMAX at the start of a rainfall event. ZACT is usually nearest to ZMAX when soil moisture is nearing maximum capacity.	5.2
ZMIN (mm/hr)	Minimum infiltration rate		0
POW (>0)	Power of the soil moisture-percolation equation	POW determines the rate at which sub-soil drainage diminishes as the soil moisture content is decreased. POW therefore has significant effect on the seasonal distribution and reliability of drainage and hence baseflow, as well as the total yield from a catchment.	2
PI (mm)	Interception storage capacity	PI defines the storage capacity of rainfall that that is intercepted by the overhead canopy or vegetation and does not reach the soil zone.	2
AI (-)	Impervious portion of catchment	AI represents the proportion of the catchment that is impervious and directly linked to surface water drainage pathways.	0
R (0,1)	Evaporation – soil moisture relationship	Together with the soil moisture storage parameters ST and SL, R governs the evaporative process within the model. Two different relationships are available. The rate of evapotranspiration is estimated using either a linear (0) or power-curve (1) relationship relating evaporation to the soil moisture status of the soil. As the soil moisture capacity approaches, full, evaporation occurs at a near maximum rate based on the daily pan evaporation rate, and as the soil moisture capacity decreases, evaporation decreases according to the predefined function.	0
DIV (-)	Fraction of excess rainfall allocated directly to pond storage	DIV has values between 0 and 1 and defines the proportion of excess rainfall ponded at the surface due to saturation of the soil zone or rainfall exceeding the soils infiltration capacity to eventually infiltrate the soil, with the remainder (and typically majority) as direct runoff.	0.8
TL (days)	Routing coefficient for surface runoff	TL defines the attenuation and time delay of surface water runoff.	1
GL (days)	Groundwater recession parameter	GL governs the attenuation in groundwater discharge or baseflow from a catchment.	1

Parameter	Name	Description	Calibrated Value
QOBS (m^3/day)	Initial stream volume	QOBS defines the initial volume of water in the stream at the model start period and is used to precondition the soil moisture status.	126,900
AA, BB	Coefficients for rainfall disaggregation.	Used to determine the rainfall event duration and pattern.	0.22, 0.216

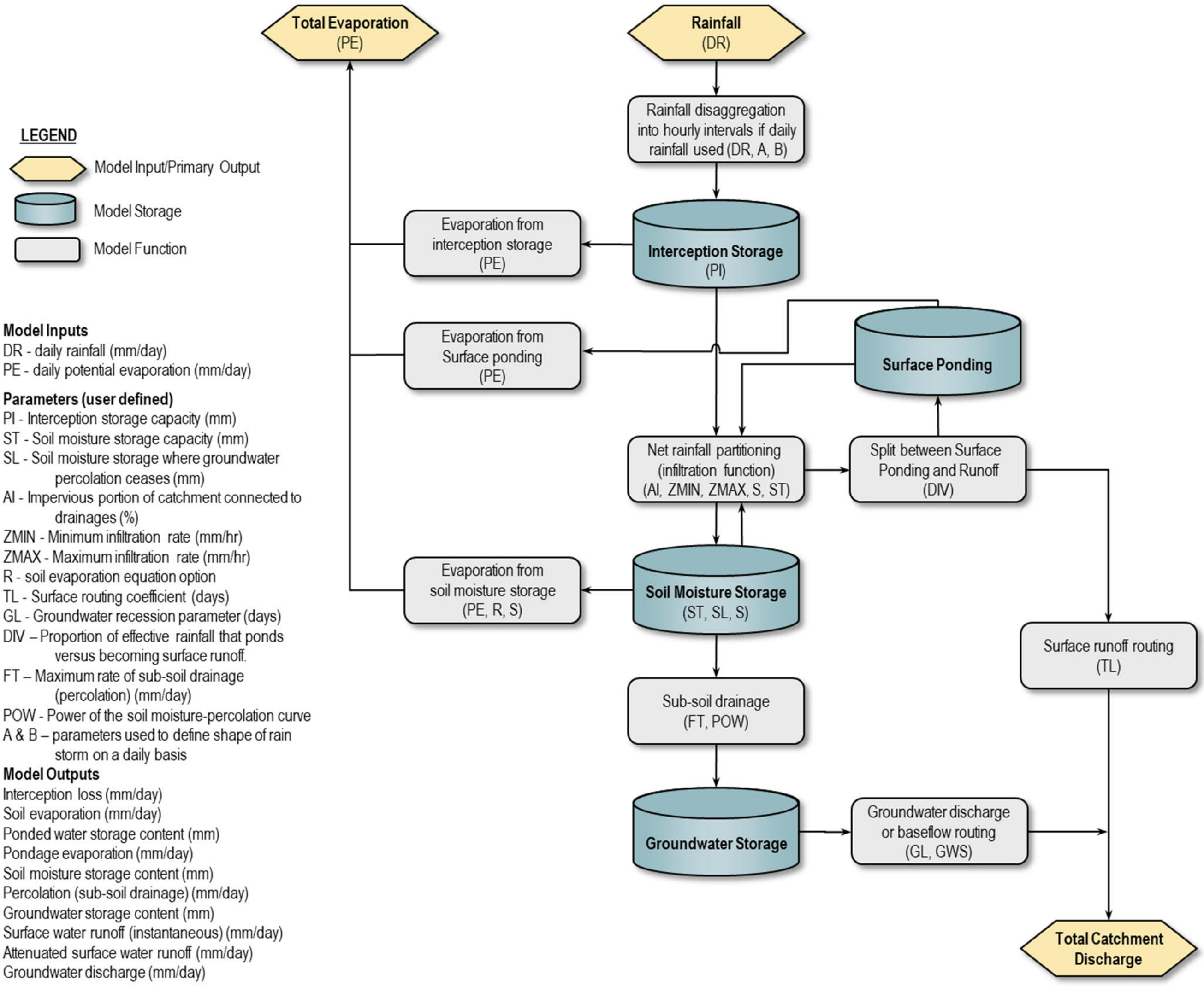


Figure 24. Schematic overview of the SMWBM.

Appendix B. SOURCE Modelling

The SOURCE modelling framework was utilised to model the conceptual operation of the storage reservoir and effects on the downstream flow regime. SOURCE is a hydrological modelling platform developed by the Australian research and not for profit organisation eWater. The platform is comprised of an interface integrating various models (as plugins) and internal tools designed to simulate and extract results for all aspects of water resource systems at a range of spatial and temporal scales.

The schematic modelling component of SOURCE was used to model the conceptual storage operation. The schematic model comprises of a series of linked nodes, representing individual components of the scheme, and rules and constraints on the transfer of water between nodes.

A schematic of the SOURCE model setup is shown in **Figure 25**.

The key node types used in the scheme storage optimisation modelling included:

- **Storage Nodes –** are used to represent storages such as dams, reservoirs, weirs and ponds. Storage Nodes calculate the daily water balance and are governed and constrained by inflows, physical limits on discharges (i.e. outflow pipe or pump capacities), downstream demands and gains (direct rainfall on reservoirs) and losses (evaporation for the reservoir surface). The storage node was configured based on the current conceptual design of the reservoir (WWLA, 2020c).
- **Inflow Nodes –** provide a source (inflow) of water to Storage Nodes. Inflow Nodes were configured with time series extracted from the catchment models (**Section 4Error! Reference source not found.**), representing direct catchment inflows to the reservoir and take locations.
- **Supply Point Nodes –** define a location where water can be extracted to meet a demand required by Water User Nodes. Supply Point Nodes provide a means of constraining extractions (takes) based on physical constraints such a maximum pumping capacity, or when reservoir storage volumes are above or below a specified level.
- **Water User Nodes –** define a water take demand profile, and are always located immediately downstream of a Supply Point Node. Water user nodes simply represent a water take (demand) from a Storage Node, on the condition that sufficient volume of water is available within the storage, and the take is within the constraints of the upstream Supply Point Node. A water user node was configured for the irrigation take. The irrigation take was defined based on the outputs of the SMWBM_Irr model (WWLA, 2020a), for a 100-hectare irrigable area, and a peak application rate of 4.3 mm/day.
- **Pipe Junction Nodes –** are used to transfer water between locations, and to represent pump stations in a water supply system. They operate using a rules-based ordering system. Pipe junction nodes were configured to represent the harvesting of water to storage in the reservoir. Pipe junctions were used to simulate the harvesting of above median flows from the Te Ruaotehauhau Stream, upstream of the reservoir.

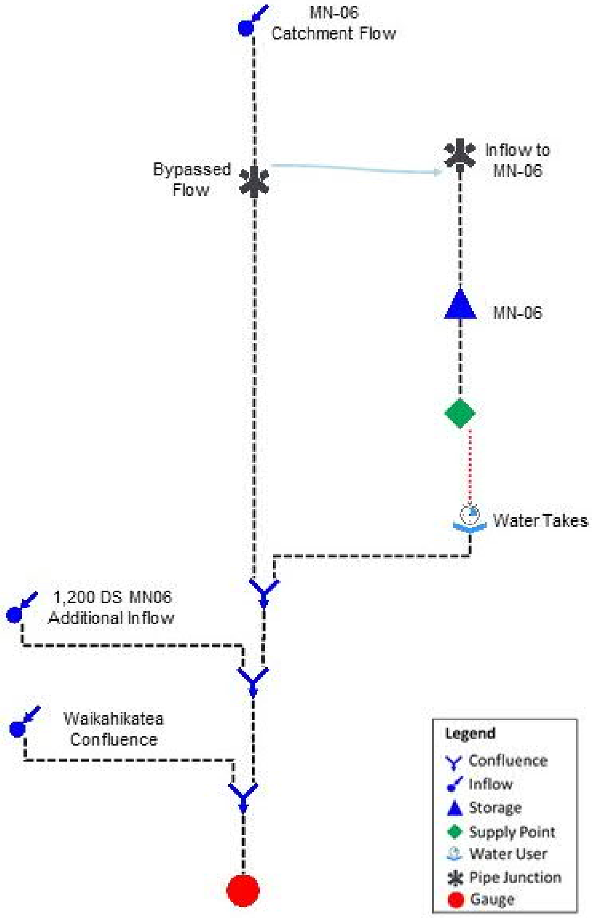
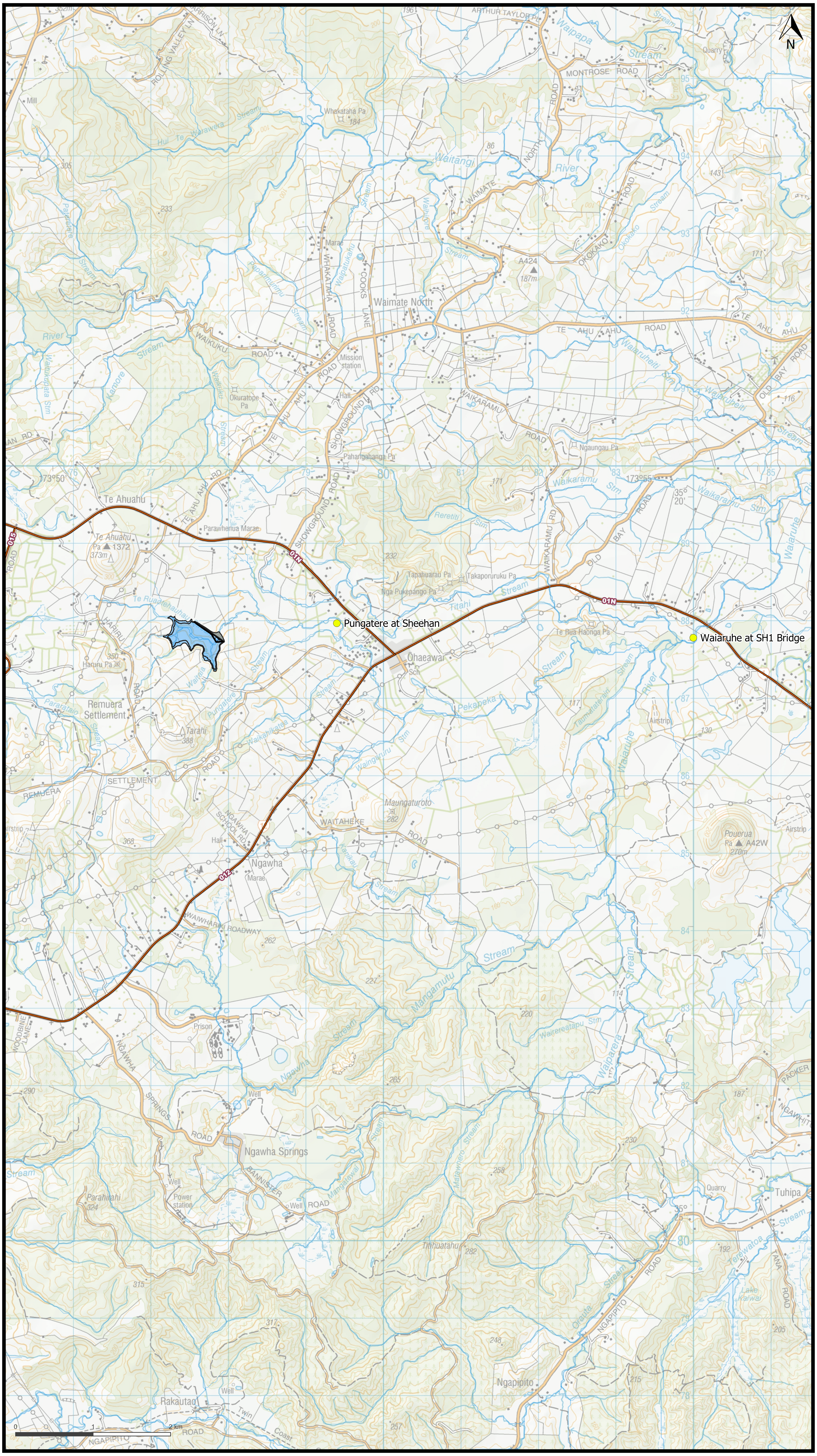


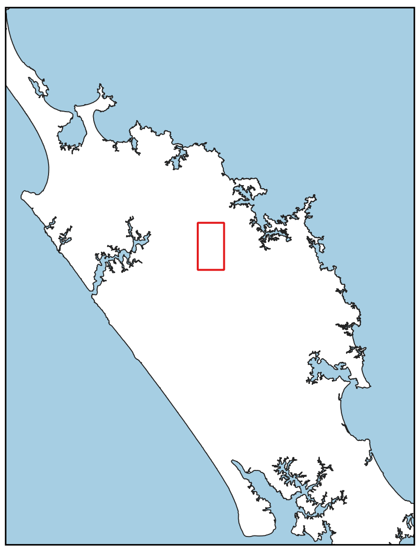
Figure 25. SOURCE model schematic.



Map Title:
Available Flow Gauging Locations

Project:
Te Ruaotehauhau Water Storage Reservoir Hydrology Study

Client:
Te Tai Tokerau Water Trust



Legend

●	**Flow Gauging Locations**
—	**River / Stream**
—	**State Highway**
🟦	**Reservoir Footprint**

Data Provenance
Topographic Data derived from Land Information New Zealand

Layout & Project File
Flow Gauge Locations
MN-06_Hydrology_Study_Report EL.qgz

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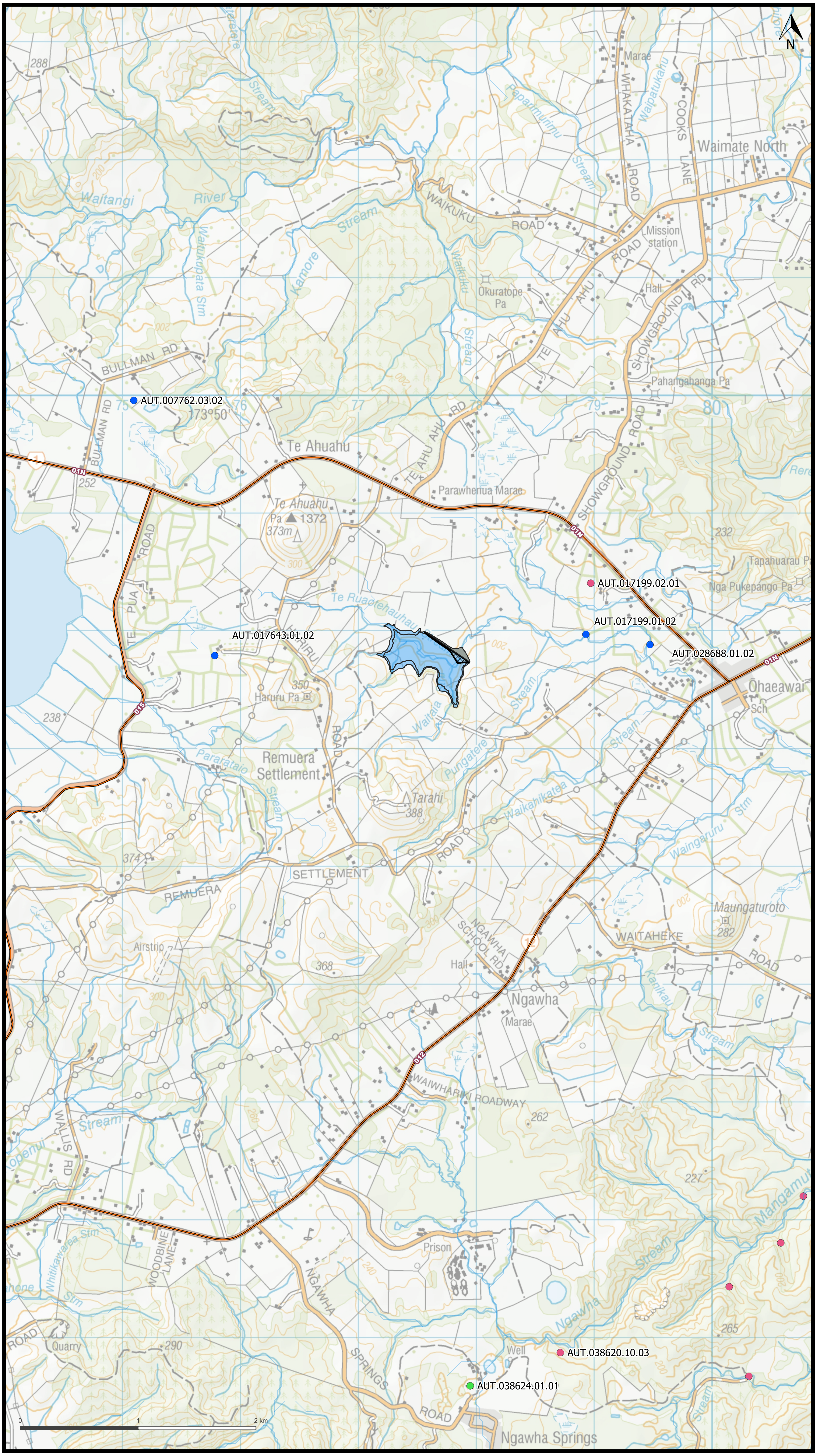
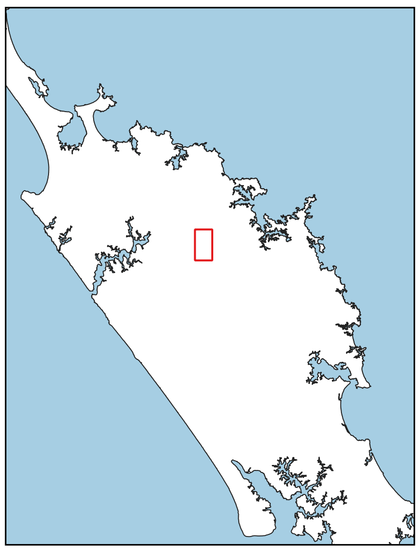
Figure 03.



Map Title:
Consented Water Takes

Project:
Te Ruaotehauhau Stream Water Storage Reservoir Hydrology Study

Client:
Te Tai Tokerau Water Trust



Legend

- ● **Dam Water Take**
- ● **Geothermal Fluid Take**
- ● **Surface Water Take**
- — **State Highway**
- — **River / Stream**
- ▨ **Lake**
- ▨ **Reservoir Footprint**

Data Provenance
Topographic Data derived from Land Information New Zealand

Layout & Project File
Consented Water Takes
MN-06_Hydrology_Study_Report EL.qgz

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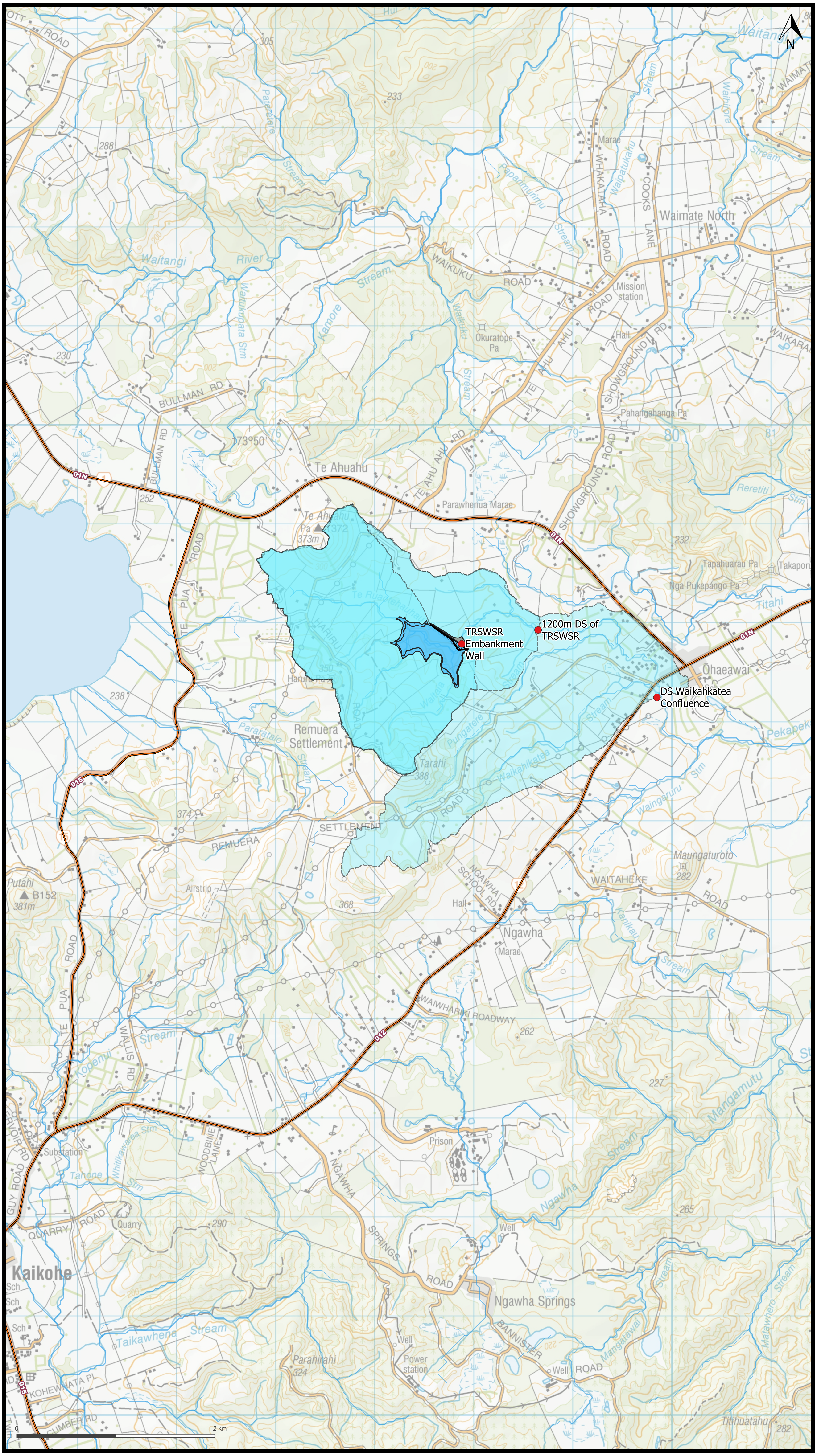
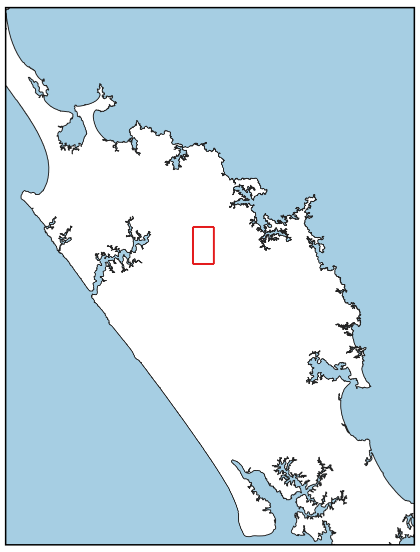
Figure 04.



Map Title:
Representative Assessment Locations

Project:
Te Ruoteahuahu Stream Water Storage Reservoir Hydrology Study

Client:
Te Tai Tokerau Water Trust



Legend

- ● **Assessment Location**
- **River / Stream**
- **State Highway**
- ▭ **Assessment Location Catchment**
- 🟦 **Reservoir Footprint**

Data Provenance
Topographic Data derived from Land Information New Zealand

Layout & Project File
Assessment Locations
MN-06_Hydrology_Study_Report EL.qgz

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Figure 09.

LEGEND

—	5m CONTOURS
— · —	PROPERTY BOUNDARY
—	STREAM CHANNELS
▨	INUNDATION TO FULL SUPPLY LEVEL (FSL)
TP1	TEST PIT
△ CPT1	CONE PENETROMETER TEST

REFERENCE NOTES:

1. CONTOURS AND AERIAL PHOTO SOURCED FROM 2019 NORTHLAND REGIONAL COUNCIL LIDAR.
2. MAXIMUM INNUNDATION AREA ILLUSTRATES THE AREA LIKEY TO BE INNUNDATED ASSUMING A NOMINAL 20m BUFFER.

40 0 80 160m

SCALE 1:4000

FOR CONSENT

REV	DATE	ISSUE	BY
1		FOR CONSENT	MP

DESIGN EM
DES CHECK
APPROVED FOR ISSUE
DRAWN MP
CAD CHECK
DRAFT
DATE DRAWN AUG. 2020
ISSUE DATE 05 / 08 / 20

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CLIENT TE TAI TOKERAU WATER TRUST
ADDRESS NORTHLAND
PROJECT DAM MN06 WATER STORAGE AND USE PROJECT
SHEET TITLE SITE PLAN AND INVESTIGATIONS

ACENZ

CADFILE 200240_3–102.dwg
SCALE (A3) 1:4000
ORIG. SHEET SIZE A3
DRAWING No. 200240/3-102
REV. 1

Appendix D. Geotechnical and Site Suitability Assessment Report

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GEOTECHNICAL AND SITE SUITABILITY ASSESSMENT

TE RUAOTEHAUHAU WATER STORAGE RESERVOIR, OHAEWAI

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RILEY CONSULTANTS

GEOTECHNICAL AND SITE SUITABILITY ASSESSMENT TE RUAOTEHAUHAU WATER STORAGE RESERVOIR, OHAEWAI

Report prepared for: Te Tai Tokerau Water Trust

Report prepared by: Shael Monk-Fromont, Geotechnical Engineer

……………………………

Report reviewed by: Eli Maynard, Senior Water Resources/Geotechnical Engineer, CPEng

Eli Maynard.
……………………………

Report approved for issue by: Scott Vaughan, Managing Director, CPEng

……………………………

Report reference: 200240-E

Date: 1 September 2020

Copies to:

	Te Tai Tokerau Water Trust	Electronic copy
	Williamson Water and Land Advisory	Electronic copy

Issue:	**Details:**	**Date:**
1.0	FINAL for Resource Consent	1 September 2020

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Appendix B: CPT Data
Appendix C: RILEY Dwgs: 200240-0 and -101 to -108

GEOTECHNICAL AND SITE SUITABILITY ASSESSMENT TE RUAOTEHAUHAU WATER STORAGE RESERVOIR, OHAEWAI

1.0 Introduction

Riley Consultants Ltd (RILEY), along with Williamson Water and Land Advisory Ltd (WWLA) and other project partners, has been commissioned by the Te Tai Tokerau Water Trust (TTTWT) to prepare documentation to support a resource consent application to construct and operate the proposed Te Ruaotehauhau Water Storage Reservoir, located west of Ohaewai.

The purpose of the reservoir is to provide a secure source of irrigable water for horticulture and non-ruminant agricultural use within the mid-north region. It is one of several options identified by the Northland Water Storage and Use Project (NWSUP): Pre-feasibility Demand Assessment and Design Study. This site was previously referred to as MN-06.

This location was initially short-listed due to its central location within and elevated above the mid-north command area, geological setting, and proximity to Lake Omapere among other criteria. The current proposal is for a 21m high embankment dam capable of storing 1.4Mm^3 at full supply level. An initial potential impact classification (PIC) by RILEY indicates that the dam will be High PIC due primarily to its location upstream of Ohaewai.

This report outlines typical design, construction, and operational considerations for the reservoir, outlined with reference to the New Zealand Society of Large Dams (NZSOLD) Dam Safety Guidelines.

The primary objectives of the geotechnical and site suitability assessment is to:

- Assess the geological context of the dam site and reservoir basin, and how this influences dam concept options, design considerations, safety, water retention and reservoir slope integrity.
- Assess if any geological or geotechnical conditions exist that could prohibit safe and cost-effective dam construction and operation.
- Refine the most suitable dam type and conceptual arrangements for appurtenant structures based on geological, geotechnical, ecological and hydrological considerations.
- Outline recommendations for the progression of the project through detailed design investigations and detailed design.

At the time of writing this report, additional intrusive geotechnical investigations (machine boreholes and laboratory testing) were being undertaken to support future detailed design. This report, therefore, provides an assessment based on present understanding using available geotechnical information captured to-date. The findings presented will need to be reviewed and updated once machine boreholes and laboratory testing can be completed.

1.1 Supporting Documents

This report should be read in conjunction with RILEY Report Ref: 200240-F titled Hydrology and Hydraulics which covers aspects such as temporary flood diversion during construction, spillway requirements and an initial dam failure and consequence assessment.

2.0 Site Description and Topography

The proposed Dam site is located on a volcanic plateau at the confluence of Te Ruaotehauhau and Waitaia streams, approximately 2.5km upstream of Ohaewai, Northland.

Topography comprises a generally flat terrace on the left abutment and moderate slopes on the right, each formed by pre-historic lava flows (Figure 1). The catchment is predominantly in pasture, with isolated areas of wetland and forest predominantly along riparian margins.

Figure 1: View west from right abutment along main dam alignment. Te Ahuahu scoria cone partly obscured by fog in the middle background.

The stream running through the site meanders around the inferred boundary between separate volcanic lava flows. The main channel is slightly incised into weathered rock and is less than 10m wide at its base and up to about 100m wide at its highest point (RL 200m). The stream is fed by springs emanating at several locations within the reservoir basin. This stream, along with a number of others, flow eastwards to the Waitangi estuary where it joins the Bay of Islands.

Lake Omapere is located 3km to the west of the site and is 30m higher in elevation than the proposed Dam site.

3.0 Geotechnical Site Investigations and Laboratory Testing

3.1 Investigation Scope

Geotechnical investigations have been undertaken at the site, involving:

- An initial review of broad geotechnical issues across the mid-north region as part of the Northland Water Storage and Use project: Pre-feasibility Demand Assessment and Design Study.
- A site walkover assessment of the dam alignment and reservoir surrounds including detailed geomorphic field mapping.
- Excavation of eleven test pits spread across the dam embankment, borrow areas and reservoir basin. Retrieval of bulk soil samples for future laboratory testing.
- Advancement of six cone penetration tests (CPTs) to a maximum depth of 9.7m.

The above scope of investigation is deemed appropriate to support a preliminary feasibility assessment and preliminary design to support an application for resource consent. Further investigation will be required to support detailed feasibility and final design to support an application for building consent. The requirement for and scope of additional deep investigations required to support detailed design are discussed in Section 7.0.

3.2 Desktop Study and Initial Site Visit

A high-level review of available geotechnical information across the Kaipara and mid-north was undertaken as part of the wider assessment. This looked into likely ground conditions and the potential variability across several reservoir sites, and for highlighting any known regional hazards that should be considered in the context of shortlisting and concept design for the water storage and distribution scheme.

Information was obtained from the following sources:

- 1:250k Geological Map 2 – Whangarei, GNS Science 2009.
- New Zealand Geology Webmap v.2.3 https://data.gns.cri.nz/geology/.
- New Zealand Active Fault Database v3.3 https://data.gns.cri.nz/af/.
- New Zealand Landslide Database v.4.1 https://data.gns.cri.nz/landslides/.
- Geotechnical investigation information contained in the New Zealand Geotechnical Database https://www.nzgd.org.nz.
- Photoblique images captured in 2017 and 2018.
- Information relating to known recent or historic large dam projects nearby.
- Walkover of this site.

3.3 Geomorphic Field Mapping

Comprehensive geomorphic mapping of the reservoir basin and surrounds including gullies and steeper slopes was undertaken by a senior engineering geologist from RILEY during field investigations. This enabled surface exposure and subsurface information to be correlated to published geological map of the area, the results of which are summarised on RILEY Dwg: 200240-101.

3.4 Test Pits

Eleven test pits were excavated by Far North Roading using a 15t hydraulic excavator under the guidance and supervision of RILEY. Test locations were spatially distributed across the dam embankment and reservoir basin in key areas of interest.

Six test pits were excavated as part of the embankment foundation investigation (TP1 to TP6), four in the potential borrow areas within the reservoir basin (TP8 to TP10), and one near the auxiliary spillway (TP7).

All test pits were extended to a target depth of 5m or earlier refusal on competent rock. A RILEY engineering geologist inspected exposures within the test pits, logging the materials encountered, and any geological structures in general accordance with the New Zealand Geotechnical Society (NZGS) Guidelines. Bulk samples were retained for future laboratory testing.

3.5 Cone Penetration Tests

Six cone penetration tests with piezocone enhancement (CPTu) were advanced by Underground Investigation Ltd using a Georig 220 with a 10cm^2 100MPa probe.

All tests were undertaken within the dam embankment footprint, advancing to refusal at a maximum depth of 9.7m (CPT6). All CPT tests reached refusal due to failure of ground anchors that provide resisting force to the test rig.

4.0 Investigation Results

4.1 Geological Setting

Regional geology comprises Kerikeri Volcanic Group Early to Late Pleistocene basalt of the Kaikohe – Bay of Islands Volcanic Field underlain by Northland Allochthon (1:250k QMAP 2 Whangarei, GNS Science 2009).

The provisional dam location has been selected within a local gully on a volcanic plateau formed by lava flows inferred to originate from three prominent scoria cones: Tarahi Volcano to the south, Maungakawakawa to the south-west, and Te Ahuahu to the north-west. GNS Science (2009) indicates that the age of these volcanos is in the range 60ka (thousand years) to 1,400ka. Older deposits, in the order of 1,800ka to 9,700ka are indicated to the north and south of these volcanos and may underly the younger volcanic deposits at the site. Other studies of the Kaikohe – Bay of Islands Volcanic Field (e.g. Dr Bruce Hayward, 'Out of the Ocean into the Fire') suggest that all the volcanoes erupted in the last 300,000 years, and that many are likely younger than 100,000 years.

'Geology of the Whangarei Area' (GNS Science, 2009) describes the typical eruption sequence of volcanism in the Kaikohe-Bay of Islands volcanic field. Typically, there is an initial vent-opening explosion, which is followed by weakly energetic eruption of ash, scoria and bombs, fluid lava effusion follows. The volcanic deposits are constrained by topography of the time, often filling valleys, and burying deposits of alluvium.

The site is located on the lower northern slopes of the Tarahi volcano, which forms the highest scoria cone in the Kaikohe Volcanic Field, approximately 140m above the surrounding flows. The Maungakawakawa volcano to the west forms a 60m high scoria cone that breached to the north-west and formed radially running volcanic flows. The Te Ahuahu volcano forms a prominent scoria cone rising 100m above its east-west trending flows below.

Due to the eroded nature of the Tarahi and Maungakawakawa volcanoes, they are both interpreted to be older than the Te Ahuahu. Basalt lava typically has a low viscosity erupting with effusive volcanism.

The Kaikohe – Bay of Islands Volcanic Field is underlain at depth by structurally complex units of tectonically intercalated sandstone and mudstone of the Northland Allochthon. The materials of the Northland Allochthon are inferred to rest on basement rock of the Waipapa (Composite) Terraine. The basement Waipapa Group greywacke rock is indicated to be at a depth greater than 500m below ground level (bgl).

4.2 Observations from Site Walkover

The following observations were made by RILEY during the geomorphic and geologic field mapping undertaken on 6 to 7 May 2020.

The dam site is located at the boundary of three intercalated basaltic lava flows: the left abutment originating from the Te Ahuahu volcano (north), the right abutment from the Tarahi volcano (south), and west extent of the reservoir from the Maungakawakawa volcano (west). The flows formed by the Te Ahuahu volcano form a wide ridge that gently slopes east, where the flows formed by the Maungakawakawa and Tarahi volcanoes slope more moderately north-west and north.

There were no obvious signs of large-scale slope instability on the abutments of the Dam site. Observed instability is limited to localised small scale rockfall on the left abutment and shallow soil movement on the right abutment. Both these areas are adjacent to the main stream channel and assessed to be due to toe-erosion and resulting oversteepening of the slopes. The shallow soil movement is typically observed as terracettes.

Springs were observed around the reservoir basin at several locations, often found at the heads of gullies, as well as within several test pits perching at the contact between the residually weathered soils and underlying rock.

Outcrops of slightly weathered basaltic boulders are typically observed at the surface of the Tarahi lava flows, and not the Te Ahuahu and Maungakawakawa flows. This is likely due to the gentle slopes formed by the Tarahi lava flows and its younger age. The boulders typically range from 0.5m to 2.0m in diameter.

Slightly upstream of the proposed Dam site near the intersection of two stream channels, is a flat-lying area at the base of the slopes, which due to its close-proximity to the stream and geomorphology, may include deposits of alluvium.

4.3 Ground Model

4.3.1 Stratigraphy

Surficial soils observed in test pits were predominantly described as dark reddish brown with purple and orange silt and clay with minor fractions of sand, gravels and cobbles. These are interpreted as residually weathered basalt of the Kerikeri Volcanic Group.

The weathering depth was variable but generally in the order of a few metres thick, beneath which unweathered, hard basalt was encountered. Deeper weathering was generally observed on the right abutment, suggesting the deposits from Tarahi volcano are likely to be older than on Te Ahuahu Volcano on the left.

Basaltic rock is known to weather more rapidly and variably compared to other volcanic rock types. As these materials are potentially deposited by explosive volcanic episodes, potential ash, lapilli, blocks and scoria layers between flows at depth cannot be discounted. Further, being a relatively recent flow deposit means that intercalated or overlapping flows with intermediate soil deposits that have been preserved are possible. For these reasons, a range of soil and rock properties are possible beneath the dam site and these will be investigated as part of detailed design. Permeability of the intact basalt rock will be governed by the persistence, width and orientation of cooling joints and other defects, which can result in very high permeabilities.

Scoriaceous gravels, ash and lapilli were identified in the borrow area at the base of TP10 from 4.3m to 4.6m+ and extends to an unknown depth. This material may have rafted down with lava flows from the breached scoria cone of the Maungakawakawa volcano located to the west of the site and may contain materials that could have high permeability.

Beneath all units is sandstone and mudstone of the Northland Allochthon, and below that basement Waipapa Group greywacke rock at depth.

Simplified ground models have been developed based on the information captured to-date. These are summarised in the following sections. Refer to RILEY Dwgs: 200240-103 and -104.

4.3.2 Left Abutment

The ground model comprises firm to stiff, silt and clayey silt with slight to moderate plasticity interpreted as residual Kerikeri Volcanics in the upper few meters. Underlying this is weathered basalt originating from the Te Ahuahu volcano. Outcrops of rock and boulders at the surface towards the stream channel indicate that rock is at a shallow depth in this area (Figure 1). As this is one of the younger lava flows in the area, the basalt encountered by the test pits and CPTs could be underlain by older lava flows and other deposits, such as alluvium. The depth of the Northland Allochthon has not yet been confirmed here.

4.3.3 Right Abutment

The description here applies to both the right dam abutment and also to the auxiliary spillway.

The ground model comprises several meters of firm to very stiff, silt and clayey silt with non to moderate plasticity interpreted as residual Kerikeri Volcanics. Underlying this is weathered basalt originating from the Maungakawakawa volcano. This volcano is inferred to be one of the older in the area, and therefore, has a deeper weathering profile compared to the left abutment. Underlying this basalt is likely to be older lava flows and other deposits, such as alluvium. The depth of the Northland Allochthon has not yet been confirmed here.

4.3.4 Foundation

Within the main valley section, the ground profile transitions between two lava flows outlined above. At the transition between flows there is often greater variability variable. The active stream channel can also increase weathering rates and initiate erosion. Soft alluvium within or adjacent to the stream channel is also likely. The depth of the Northland Allochthon has not yet been confirmed here.

4.3.5 Groundwater

Springs were observed around the reservoir basin at several locations, often found perching at the contact between the residually weathered soils and fresh rock where there is a large permeability contrast.

Moderate seepage flows were encountered within TP1 to TP3, TP5, and TP6 at depths of between 3m to 4m bgl immediately above the soil rock interface. These seepages appear to be spring-fed and have a general downslope trend toward the nearest stream channel.

On the left abutment, groundwater is only a few meters below ground level; on the right abutment groundwater was not observed above the stream channel. Within the main valley section, groundwater is likely to be at or near the same level as the stream invert.

Groundwater located within localised basalt and scoria aquifers and is used as a source for irrigation wells and municipal supply in the area.

Defining the location, thickness and hydraulic properties of the soil and rock units, along with improving understanding of the site hydrogeology and any aquifer units present, will be a key focus of future drilling work.

4.4 Dam Fill Borrow Areas

A possible borrow area for Dam fill was identified upstream of the proposed dam site to the west of the stream channel, as indicated on the appended RILEY Dwg: 200240-101. Additionally, excavations to form the auxiliary spillway will provide material that could be reused in dam construction.

Test pits TP7, TP8, TP9, TP9A, and TP10 undertaken by RILEY were sited to provide an assessment of the suitability of the soil material within this area. These test pits encountered 3m to 4m of cohesive silt and clay with slight to moderate plasticity, which could be suitable as earthfill subject to further assessment. Recorded shear strengths were typically between 50kPa and 200kPa+ i.e. stiff to very stiff conditions.

Other potential borrow areas around the reservoir basin could be considered depending on volume requirements.

Unweathered rock, such as that observed near ground surface on the left abutment, and possibly some excavated during excavation of the auxiliary spillway, could be suitable for reuse as riprap on the upstream face subject to further assessment.

5.0 Natural Hazards

5.1 Seismicity

Seismic/earthquake risk in Northland is generally low by national standards, with no recorded large earthquakes since records began (c. 1840).

Seismicity here is dominated by distributed or background seismicity used to model historical earthquakes, rather than known active fault sources in the area. No fault sources are known to exist in the vicinity of the site, with the closest active fault being a possible northern extension of the Kerehepu Fault in the Hauraki Golf nearly 200km away. Inactive faults associated with the emplacement of the Northland Allochthon are noted to occur throughout the area, and are not considered to require specific consideration for design.

Notwithstanding that, seismic aspects will be a design consideration and being a High PIC means that specific assessment will be undertaken to inform detailed design.

This will typically involve evaluation of the following scenarios during detailed design:

- Operating Basis Earthquake (OBE) – The earthquake for which a dam, appurtenant structure, and gate/valve system that fulfils a dam safety function is designed to remain operational, with any damage being minor and readily repairable following the event. It is considered that an annual exceedance probability (AEP) of 1 in 150 is appropriate for the OBE.
- Safety Evaluation Earthquake (SEE) – The earthquake that would result in the most severe ground motion, which a dam structure must be able to endure without uncontrolled release of the reservoir. It is considered that AEP of 1 in 10,000 is appropriate for the SEE based on the assessed High PIC.
- Controlling Maximum Earthquake (CME) – The maximum earthquake on a seismic source that is capable of inducing the largest seismic demand on a dam.

Due to the long recurrence interval design events, seismic parameters for use in design of a High PIC dam are normally established by a site-specific seismic hazard assessment by a technical specialist, using a probabilistic analysis. We are aware of two such studies undertaken for the following large High PIC dams in Northland:

1. Kerikeri Irrigation Dams, 10km north-east of the site (GNS Science, 2015).
2. Whau Valley Dam, west of Whangarei (GNS Science, 2012).

Both studies provide recommended ground motions for the SEE. Additionally, the Whau Valley Dam study provides estimates for a M6.5 normal faulting earthquake at a distance 20km from the site. In the absence of any nearby known active fault, this earthquake is used to develop a default minimum ultimate limit state (ULS) spectrum in NZS 1170.5 in low seismic regions, such as Northland.

Based on present information, the site would be classed as either Site Class B ‘rock’ or Class C ‘shallow soil’ in accordance with NZS 1170.5.

5.2 Liquefaction

Qualitative assessment of materials encountered during excavation of the test pits was undertaken to identity potential soil types that may be susceptible to liquefaction. All materials were described as either firm to stiff cohesive silt and clay or rock, which are not considered susceptible for liquefaction or considerable strength loss on cyclic loading.

A preliminary liquefaction assessment was also undertaken on the CPT results using updated methods (e.g. I&B 2014) and ground motions provided in the above seismic studies. Results indicate that the soils are either sufficiently plastic or dense to liquefy, and this will be confirmed once additional investigations are completed to support detailed design.

These preliminary results from the seven CPTs, together with the low regional seismicity, indicates that liquefaction is unlikely to pose a significant risk to this dam. Notwithstanding this, consideration of potential for liquefaction in deeper soil layers will be assessed once machine borehole findings are available.

As noted, fine grained soils with significant plasticity are not considered liquefiable. However, soft or sensitive cohesive sediments can be subject to cyclic softening. The mechanism for this softening is similar to liquefaction insofar as high intensity cyclic loading can cause significant shear strains to accumulate, with a corresponding increase in pore pressure and reduction in shear strength. This will be considered further during detailed design.

5.3 Volcanic Activity

The Kaikohe – Bay of Islands field is generally considered to be dormant, and many of the volcanos are thought to have erupted in the last 100ka. Geologists are continuing work to date volcanos in the field. Dr Bruce Howard refers to Te Puke and Tauanui volcanos as among the youngest centres in the field with dates of 75ka, and 45ka, respectively. Work is continuing amongst geologist to estimate the recurrence interval of volcanic eruption within the field. Kear and Thompson (1964) suggested 1ka to 2ka, but GNS Science (2009) indicate it is probably much longer than this.

Volcanos within the Kaikohe – Bay of Islands field have dominantly been identified as monogenetic, meaning each volcanic sequence forms a new volcanic vent rather than erupting from an existing volcano. For this reason, the volcanic hazard affects the entire volcanic field rather than specific volcanos, such as those surrounding the site. Bogalo (2000) estimated that a future basalt eruption within the field would directly affect by an area of up to 78km^2, including lava flows typically 5km in length and ashfall over an area up to 20km^2.

There are no practical steps that can be taken from a design perspective to mitigate the volcanic hazard. Emergency preparedness and resilience should be considered.

5.4 Landslides

Landslides can threaten the dam embankment or safe operation of the reservoir in a variety of ways. Examples include:

- Reservoir operation could result in reactivation or new landslides around the reservoir basin impacting the dam, appurtenant structures, adjacent land or increasing sedimentation.
- Landslide-generated waves impacting communities adjacent to the reservoir, or to the dam itself resulting in overtopping.
- Excavations for embankment foundation preparation, or to form the spillway channel, could initiate ground movement.

Geomorphic mapping of the dam abutments and reservoir basin did not identify any signs of large scale or deep-seated slope instability, and is generally not anticipated within this volcanic setting.

Signs of small-scale surficial landslips developed at the rock/soil contact, minor rockfalls, and shallow soil creep were observed. These features are reasonably common in the area and often manifest after periods of extended rainfall. The key features of interest were located near or below the proposed maximum reservoir line as shown on RILEY Dwg: 200240-101. As the intention is to draw down the reservoir either partially or fully across a season, reservoir operation may exacerbate or promote minor slumping or slips developing around the reservoir basin that will be need to be specifically assessed.

Long-term excavations are proposed at the borrow area and in forming the auxiliary spillway. The former will likely involve excavations in the order of 3m to 4m deep; the latter could be more significant up to 9m deep. All cut slopes will be specifically assessed as part of detailed design to ensure target factors of safety will be met, in particular where slopes will be fully or intermittently submerged, such as the borrow area.

Generally, the dam concept does not involve any long-term slope toe excavations or slope surcharging. The soils strengths indicated from the in-situ shear strength testing, do not indicate any obvious slope instability hazard in the slopes within the reservoir basin or dam abutments. Notwithstanding this, further consideration of stability for any permanent cut slopes required to form the spillway and borrow area as outlined above are necessary, as well as stability of temporary excavations required for undercutting of soft unsuitable soils in the dam footprint. Options such as battering, benching or slope retention could be considered to improve factors of safety should this be required.

Slopes across the region comprising of Northland Allochthon material are known to be prone to instability. While Northland Allochthon is present beneath the volcanic deposits, investigation at the site to-date has not encountered it at shallow depths, where it would influence the stability of the slopes.

5.5 Flooding

Detailed analyses of the site catchment, temporary flood diversion during construction, and permanent spillway facilities are provided in the Hydrology and Hydraulics Assessment (RILEY Ref: 200240-F).

6.0 Preliminary Dam Design

Whilst a number of potential geotechnical hazards have been considered, based on the investigations undertaken to-date, we have not identified any specific geotechnical hazards that indicated the possible dam site is unsuitable. The following provides comment on specific elements considered for preliminary design.

6.1 Dam Type and Spillway

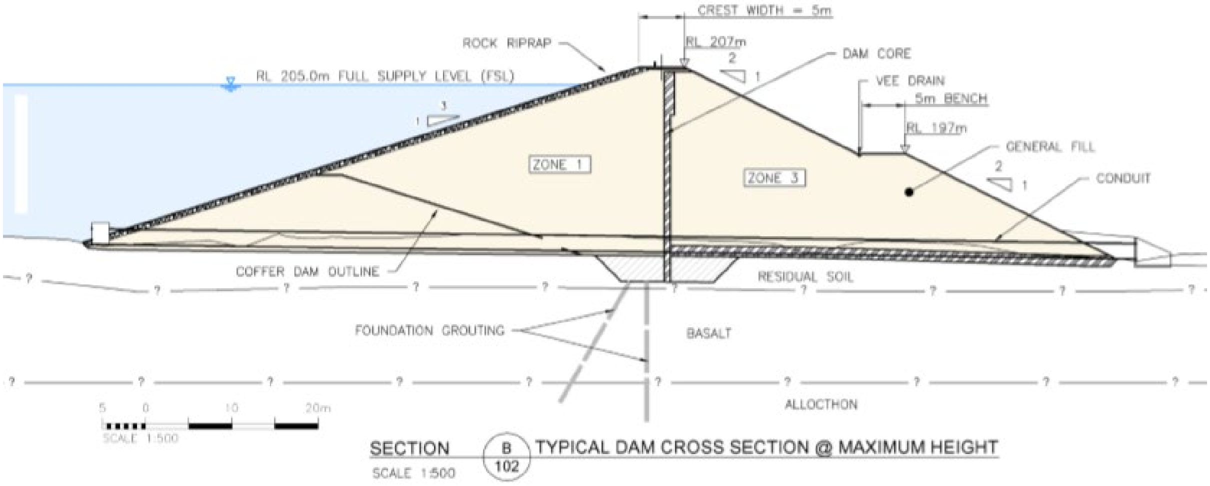
The site topography and interpreted ground model indicate conditions suitable for an embankment dam. Based on a storage requirement of 1.4Mm^3, the dam embankment would be up to approximately 21m high in the main valley section and around 400m long. Only the central portion (~50m in length) is in the order of 10m to 20m high, with majority of its length on the left abutment being generally less than 5m.

A preliminary design cross section is presented in Figure 2 and on the appended RILEY Dwg: 200240-105. The embankment has up- and down-stream slope batters of 1V:3H (horizontal : vertical) and 1V:2H with a 5m wide mid-height bench, and minimum 5m wide crest. A wider crest could be considered depending on future access requirements.

The embankment itself could be zoned, utilising selected low-permeability, cohesive silt and clay as the upstream shoulder and general earthfill (probably still cohesive material) in the downstream shoulder. The zones would be separated by a central chimney drain with blanket or finger drain outlets to control seepage and internal erosion. The embankment would be founded on stiff residual soil or weathered rock, with preparation involving grouting, dental treatment and keyways as required.

A low-level conduit installed within the valley floor at the toe of the left abutment would provide temporary flood diversion during construction, house both a residual flow pipe and supply pipes and provide emergency dewatering facilities. The current concept includes both service/primary and auxiliary spillways. The service spillway could be incorporated into either the left or right abutment; the auxiliary spillway is envisaged to be formed beyond the right abutment, discharging to the stream approximately 200m below the dam. The service spillway could also be incorporated within the auxiliary spillway. Refer to RILEY Dwg: 200240-106.

Figure 2: Preliminary Dam Cross Section



The concept design outlined above is based on the Kerikeri irrigation dams constructed in the early 1980s. The two Kerikeri dams are both higher, also High PIC, are underlain by similar Kaikohe – Bay of Islands Volcanic rock and were constructed using similar residual soil. These have largely performed well since their construction in the mid-1980's.

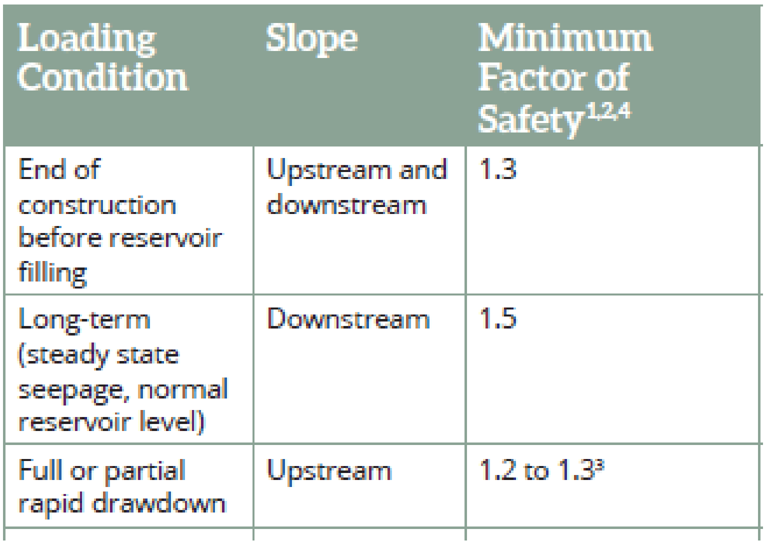
6.2 Design Standards

The Dam has been assessed as having a High PIC (refer RILEY Ref: 200240-F). Design standards in keeping with a High have, therefore, been adopted in accordance with the NZSOLD Guidelines as follows:

- Operating Basis Earthquake (OBE): 1:150 AEP ground motion.
- Seismic Evaluation Earthquake (SEE): 1:10,000 AEP ground motion developed by a probabilistic approach.
- Inflow Design Flood (IDF): 1:10,000 AEP event to Probable Maximum Flood (PMF).

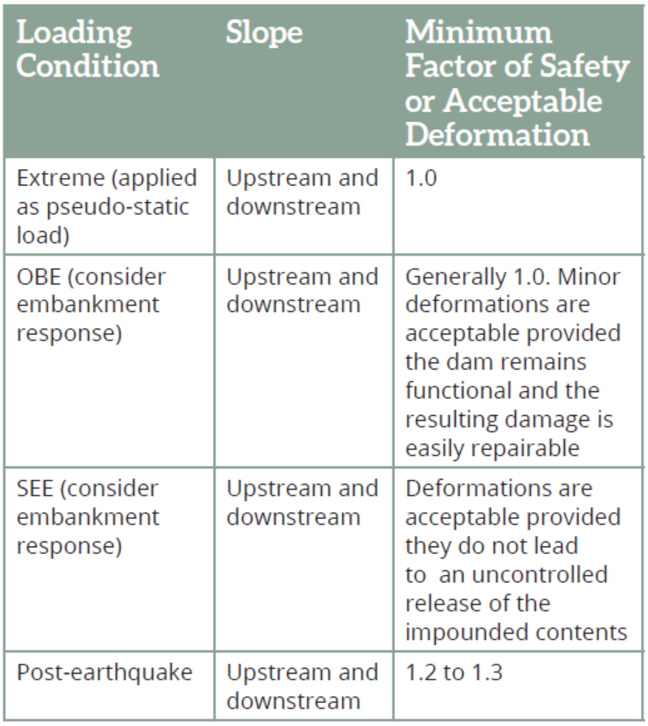
Performance standards and recommended factors of safety are nominated by the NZSOLD Guidelines for a range of operational and emergency scenarios. Minimum stability requirements adopted for design for non-seismic load cases are as set out in Table 1. Seismic performance standards are set out in Table 2.

Table 1: Minimum Factors of Safety for Slope Stability – Static Assessment (reproduced from NZSOLD, 2015)



Loading Condition	Slope	Minimum Factor of Safety^{1,2,4}
End of construction before reservoir filling	Upstream and downstream	1.3
Long-term (steady state seepage, normal reservoir level)	Downstream	1.5
Full or partial rapid drawdown	Upstream	1.2 to 1.3^{3}

Table 2: Minimum Requirements for Slope Stability – Seismic Assessment (reproduced from NZSOLD, 2015)



Loading Condition	Slope	Minimum Factor of Safety or Acceptable Deformation
Extreme (applied as pseudo-static load)	Upstream and downstream	1.0
OBE (consider embankment response)	Upstream and downstream	Generally 1.0. Minor deformations are acceptable provided the dam remains functional and the resulting damage is easily repairable
SEE (consider embankment response)	Upstream and downstream	Deformations are acceptable provided they do not lead to an uncontrolled release of the impounded contents
Post-earthquake	Upstream and downstream	1.2 to 1.3

6.3 Foundations and Abutments

6.3.1 Foundation Treatment

Soils observed within the embankment footprint were generally stiff, low-permeability, cohesive and are non-liquefiable. Shear vane testing at regular intervals in test pits typically recorded undrained shear strengths in the range of 50kPa to 200kPa+, i.e. stiff to very stiff consistency. Discrete zones of saturated silts had shear strengths as low as 30kPa.

Based on the above, only a nominal stripping and undercut up to a few meters appears to be needed to remove any soft zones for stability or settlement purposes, i.e. to ensure the foundation has sufficient strength and to limit consolidation settlement. Preliminary 1D settlement analyses suggest expected settlements are within manageable ranges. It is possible that a full undercut is only warranted within the main valley section where the embankment is highest, and this should be subject to further assessment.

In addition to the above, foundation grouting and dental treatment to seal any open voids or joints if these are encountered (noting that none have been identified to-date), or alternatively an upstream clay blanket, such as those constructed for the Kerikeri dams, may be required to limit foundation seepage through jointed basalt beneath the dam.

6.3.2 Abutment Treatment

The depth to unweathered rock on the left abutment is in the order of 3m to 4m, and whilst this would be relatively straightforward to excavate, such an undercut may not be required given the lower embankment height as the loads imposed on the ground are smaller and the potential leakage path is longer. This also applies to the right abutment where the depth to rock appears much deeper and may not be feasible to excavate down to.

Dam fill could then be keyed in and compacted against the abutments. If potentially dispersive or high permeability soils are encountered in the abutments, it is envisaged this will be removed completely to the underlying cohesive horizon and benched into the abutment.

6.4 Reservoir and Abutment Leakage

The site geology includes stratigraphy with the potential for high permeability layers, such as basaltic, ash, tephra and scoria. Potential leakage beneath the reservoir or beneath the dam foundation or around the abutments, with associated erosion of soil through open joints within the underlying rock, is therefore, considered as potentially the most significant geotechnical issue associated with the reservoir.

Natural springs observed within the reservoir basin, some emerging some distance downstream (200m to 300m north-east) on the true-left and slightly above stream level at the dam centreline, indicate the potential for existing flow pathways within the underlying rock. These features may require local drainage and monitoring, or upstream lining if the source can be identified.

Operation of the Kerikeri irrigation dams on similar geology indicate that seepage is not excessive but does emerge beyond a ridge in the northern dam. Similar seepage could be expected here on the around the abutments, albeit that the seepage paths are reasonably long. The strong stream flows observed on-site suggest that stream losses are not significant and may relate to the upper soils within the valley providing a low-permeability capping, i.e. natural lining.

Further work is required during detailed design to better understand the site hydrogeology and how groundwater will flow through the site as a result of the proposed reservoir. Seepage through the foundation and around the abutments should be a key focus area for this work.

If required, options such as grouting beneath the embankment and lining sections of the reservoir, or partial lining with natural clay or a geomembrane, could be considered should future investigation and assessment indicate treatment is warranted.

6.5 Borrow Area Fill Suitability

Preliminary design indicates the following earthwork quantities will be required to construct the reservoir:

- Fill for dam embankment: 143,270m^3.
- Excavation of unsuitable in dam foundation: 19,600m^3.
- Excavation for auxiliary spillway: 92,610m^3.
- Balance of excavation from borrow area: 50,660m^3 plus additional from unsuitable and topsoil strip.

The earthworks quantities were estimated with following assumptions:

- Excavations for the dam foundation assume a nominal 0.5m strip plus 3m deep keyway within the main valley.
- No material from the foundation excavation is reused as dam fill.
- Volume of topsoil from auxiliary spillway excavation is ignored.
- No bulking or compaction factors applied.

Based on inspection of materials encountered within test pits and by the CPTs, and experience working with similar residual volcanics, the silt and clay in the potential borrow area and spillway excavation appear generally suitable for use earthfill in dam construction as it has a high fines content and plasticity, is not known to be dispersive, generally has good strength properties and will result in a low-permeability material once recompacted. This should be subject to laboratory testing during detailed design to confirm. The soils may be sensitive to moisture changes during placement and compaction that will require an experienced contractor to achieve design requirements. Gravel and boulder-sized inclusions, such as those identified in some of the test pits a few meters below ground level, will also need to be considered.

Bulk fill should be constructed from cohesive material with a compacted permeability no greater than 10^{-7}m/s and likely orders of magnitude less. Once compacted, the earthfill should perform well in terms of low-permeability and shear strength as outlined above. Earthworks consent is likely to be required for sourcing fill from on-site sources.

Specialist filter material for internal chimney and blanket drains, may need to be specifically processed and imported from a nearby quarry to suit the dam fill grading. Riprap for upstream wave protection should be able to be sourced from within the reservoir or nearby.

6.6 Seepage and Internal Erosion

Seepage flow through the embankment itself is anticipated to be minor owing to the low-permeability silt and clay fill proposed. As outlined above, defensive measures such as chimney, blanket and toe drains, and abutment drains beneath the downstream fill shoulder flanking the abutments designed to comply with no-erosion filter criteria will be incorporated into the design.

A critical element for seepage design is the low-level outlet pipe penetration. The stiffness contrast between the pipe and the surrounding soil leads to the potential for differential movement, and the challenges associated with recompacting fill adjacent to pipe haunch zones.

A number of defensive design features are provided for the outlet pipe including:

- Concrete encasement of the conduit, to eliminate the potential for un-compacted fill within the pipe haunch zone.
- Sloped sides to the concrete encasement, to minimise the potential for cracking in the event of dam fill settlement.
- Inclusion of a filter compatible drainage surround to the culvert.
- De-pressurisation of the culvert once it has finished functioning as the construction diversion. Filling and emptying the reservoir will be by means of a smaller pressurised pipe suspended within the main concrete pipe.

6.7 Spillway

The preliminary design incorporates both a service and auxiliary spillway as shown on RILEY Dwg: 200240-102. During detailed design, consideration will be given to located the service spillway on either the left or right abutments, or potentially incorporating this function within the auxiliary spillway.

The service spillway will be designed to have a very low-risk of erosion for the more frequent flood events; the auxiliary spillway, potentially in conjunction with the service spillway, will be designed to accommodate the probable maximum flood (PMF) events possible at the site.

We note that some erosion repair work may be required after extreme flood events when the auxiliary spillway operates, but not such that would allow the uncontrolled release of the reservoir. Both spillways would discharge into the stream downstream of the dam.

The concept design shows the auxiliary spillway excavated into natural ground beyond the right abutment. TP7 located within the proposed auxiliary spillway encountered very stiff silt and clay to the target depth of 5m. The requirement for and extent of erosion protection measures, such as energy dissipation structures or riprap will be considered as part of detailed design.

7.0 Further Assessment

Information retrieved from the geotechnical investigations to-date have provided information on the shallow geology within the dam embankment footprint, borrow area and across the site generally.

Six machine boreholes are proposed, along the dam footprint, to investigate the continuity of materials to a much greater depth. In-situ permeability (Lugeon/packer) testing will be undertaken within these boreholes. Following completion of these, the ground model will be reviewed and updated to inform detailed design.

Bulk soil samples have been retained from the test pits. These, in combination with selected samples from the machine boreholes, will be delivered to an IANZ soil laboratory for them to perform a suite of tests to better understand material characteristics and behaviour. Such information will be used to inform detailed design of the reservoir including material suitability for dam construction, strength parameters, and construction processes. A suite of laboratory testing will be confirmed following a review of the ground model after the completion of the boreholes. Testing will include Atterberg limits, hydrometer grading curves, compaction testing and other tests required for design of the dam.

8.0 Limitation

This report has been prepared solely for the benefit of the Te Tai Tokerau Water Trust as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

Recommendations and opinions in this report are based on data from limited test positions. The nature and continuity of subsoil conditions away from the test positions are inferred, and it must be appreciated that actual conditions could vary considerably from the assumed model.

APPENDIX A

Test Pit Logs

RILEY Consultants Ltd
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Addington, Christchurch, 8024
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Fax:

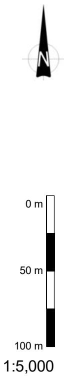
INSPECTION PIT LOG

Project: Northland Irrigation Scheme	Location: MN06 - Ohaeawai	Hole position: RILEY Dwg: 200249-102	No.: **TP01**
Job No.: 200240	Start Date: 07-05-20 Finish Date: 07-05-20	Ground Level (LINZ): 204.2m	Co-Ordinates (NZTM2000): E 1,677,373.0 N 6,087,757.0
Client: Te Tai Tokerau Water Trust	Hole Depth: 4.00 m		Sheet: 1 of 1

Elevation (m LINZ)	Depth (m)	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Weathering RS CW HW MW SW UW	Field Strength Soil | Rock VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Groundwater	Samples	In-situ / Lab Testing
+204.20									
+204.00	0.20	TOPSOIL							
+202.60	1.60	SILT with minor clay; dark reddish brown. Stiff, moist, slightly plastic [RESIDUALLY WEATHERED BASALT] 0.50m Grades to trace cobbles to boulders, highly weathered basalt, angular to subrounded 1.00m Grades to some clay, slightly to moderately plastic							P= 66 kPa R= 13 kPa P= 59 kPa R= 19 kPa P= 219 kPa
+202.20	2.00	Clayey SILT, brown with red and pink inclusions. Firm, wet, moderately plastic							
+200.20	4.00	SILT with minor clay; dark pink with white and orange inclusions. Firm to stiff, wet, slightly plastic 3.00m Grades to trace clay, trace cobbles to boulders, highly weathered basalt, angular; purple, orange, brown and pink.					▼		P= 63 kPa R= 31 kPa P= 31 kPa R= 32.5 kPa
		Sharp rock interface. Basalt lava flow EOH @ 4.00 m							

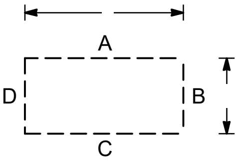
SKETCH/PHOTOS:

SITE MAP



1:5,000

Shoring/Support:
Stability:



SAMPLES AND TESTING
- ● Grab Sample (Disturbed)
- Bulk Sample (Disturbed)
- ▼ Scala Penetrometer (blows/50mm)
- ∨ Insitu Vane Shear Strength (kPa): P: Peak; R: Residual; UTP: Unable to penetrate
- Lab Testing: PSD: particle size dist. OMC: optimum moisture cont.; MDD: max dry density; Disp: dispersivity

GROUNDWATER
- ☐ None
- ☐ Slow Seep
- ☒ Rapid Inflow
- ▼ Water Strike
- Water Rise
- ▽ Time (minutes)

TERMINATION DUE TO
- ☐ Target depth
- ☐ Collapse
- ☒ Refusal
- ☐ Machine limit

Remarks

All dimensions in metres Scale 1:50	Contractor: Far North Roading Ltd	Rig/Plant Used: Machine Excavator (15 tonne)	Logged by: AHL	Checked by: SRO

RILEY CONSULTANTS
Engineers and Geologists

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Fax:

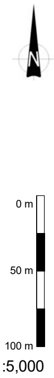
INSPECTION PIT LOG

Project: Northland Irrigation Scheme	Location: MN06 - Ohaeawai	Hole position: RILEY Dwg: 200249-102	No.: **TP02**
Job No.: 200240	Start Date: 07-05-20 Finish Date: 07-05-20	Ground Level (LINZ): 203.2m	Co-Ordinates (NZTM2000): E 1,677,666.2 N 6,087,912.9
Client: Te Tai Tokerau Water Trust	Hole Depth: 3.90 m	Sheet: 1 of 1	

Elevation (m LINZ)	Depth (m)	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Weathering RS CW HW MW SW UW	Field Strength Soil | Rock VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Groundwater	Samples	In-situ / Lab Testing
+203.20									
+203.10	0.10	TOPSOIL							
+202.40	0.80	SILT with minor clay and trace cobbles to boulders; dark reddish brown. Very stiff, moist, slightly plastic; cobbles to boulders, highly weathered basalt, angular to subrounded [RESIDUALLY WEATHERED BASALT]							P= 219 kPa
	1	SILT with minor clay; pinkish grey with white inclusions. Very stiff, moist, slightly plastic							P= 172 kPa R= 63 kPa
		1.50m Grades to some clay							P= 113 kPa R= 16 kPa
	2								P= 63 kPa R= 19 kPa
		2.50m Grades to minor clay, trace coarse sand; pinkish grey with light orange inclusions							
	3								P= 75 kPa R= 19 kPa
							▼		P= UTP kPa
+199.30	3.90								
	4	Sharp rock interface. Basalt lava flow. EOH @ 3.90 m							
	5								

SKETCH/PHOTOS:

SITE MAP



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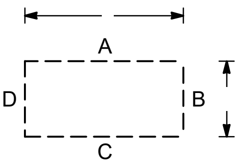
Shoring/Support:
Stability:



SAMPLES AND TESTING
● Grab Sample (Disturbed)
Bulk Sample (Disturbed)
▼ Scala Penetrometer (blows/50mm)
✓ Insitu Vane Shear Strength (kPa):
P: Peak; R: Residual;
UTP: Unable to penetrate
Lab Testing: PSD: particle size dist.
OMC: optimum moisture cont.; MDD: max dry density; Disp: dispersivity

GROUNDWATER
☐ None
☐ Slow Seep
☒ Rapid Inflow
▼ Water Strike
Water Rise
Time (minutes)

TERMINATION DUE TO
☐ Target depth
☐ Collapse
☒ Refusal
☐ Machine limit

Remarks

All dimensions in metres Scale 1:50	Contractor: Far North Roading Ltd	Rig/Plant Used: Machine Excavator (15 tonne)	Logged by: AHL	Checked by: SRO

RILEY CONSULTANTS Engineers and Geologists

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INSPECTION PIT LOG

Project: Northland Irrigation Scheme

Location: MN06 - Ohaeawai

Hole position: RILEY Dwg: 200249-102

No.: **TP03**

Job No.: 200240

Start Date: 07-05-20
Finish Date: 07-05-20

Ground Level (LINZ): 203.1m

Co-Ordinates (NZTM2000): E 1,677,733.0 N 6,087,876.0

Client: Te Tai Tokerau Water Trust

Hole Depth: 5.50 m

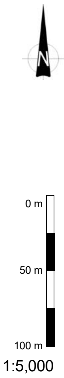
Sheet: 1 of 1

Elevation (m LINZ)	Depth (m)	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Groundwater	In-situ / Lab Testing
+203.10				
+203.00	0.10	TOPSOIL		
+202.50	0.60	SILT with minor clay, minor gravel to cobbles; reddish brown. Very stiff moist, slightly plastic; gravel and cobbles, highly weathered basalt, angular to subrounded [RESIDUALLY WEATHERED BASALT]		P= 219 kPa
	1	Clayey SILT; purplish grey with brown and orange mixed. Firm; moist to wet; slightly to moderately plastic 1.00m Grades to purplish grey brown		P= 97 kPa R= 22 kPa
	2			P= 94 kPa R= 16 kPa
+200.60	2.50			P= UTP kPa
	3	SILT, trace sand, trace cobbles and boulders; pink and orange mixed. Very stiff, wet, non plastic; sand, coarse, cobbles and boulders, highly to completely weathered basalt, angular to subrounded		P= 172 kPa R= 56 kPa
	4	4.00m Grades to minor sand, trace clay; pink, orange and light yellow mixed. Wet to saturated, non to slightly plastic	▼	
	5			
+197.60	5.50	Highly weathered basalt. Can still be excavated. EOH @ 5.50 m		

Legend | Weathering: RS CW HW MW SW UW | Field Strength: Soil | Rock: VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES | Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc) | Samples

SKETCH/PHOTO

SITE MAP



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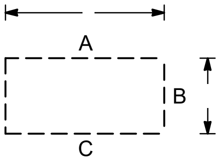
Shoring/Support:
Stability:



SAMPLES AND TESTING
- ● Grab Sample (Disturbed)
- Bulk Sample (Disturbed)
- ▼ Scala Penetrometer (blows/50mm)
- ∨ Insitu Vane Shear Strength (kPa): P: Peak; R: Residual; UTP: Unable to penetrate
- Lab Testing: PSD: particle size dist. OMC: optimum moisture cont.; MDD: max dry density; Disp: dispersivity

GROUNDWATER
- ☐ None
- ☒ Slow Seep
- ☐ Rapid Inflow
- Water Strike
- Water Rise
- Time (minutes)

TERMINATION DUE TO
- ☒ Target depth
- ☐ Collapse
- ☐ Refusal
- ☐ Machine limit

Remarks

All dimensions in metres
Scale 1:50

Contractor: Far North Roading Ltd

Rig/Plant Used: Machine Excavator (15 tonne)

Logged by: AHL

Checked by: SRO

RILEY Consultants Ltd
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Fax:

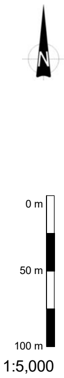
INSPECTION PIT LOG

Project: Northland Irrigation Scheme
Location: MN06 - Ohaeawai
Hole position: RILEY Dwg: 200249-102
No.: **TP04**
Job No.: 200240
Start Date: 07-05-20
Finish Date: 07-05-20
Ground Level (LINZ): 200.4m
Co-Ordinates (NZTM2000): E 1,677,793.0 N 6,087,833.0
Client: Te Tai Tokerau Water Trust
Hole Depth: 2.00 m
Sheet: 1 of 1

Elevation (m LINZ)	Depth (m)	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Weathering RS CW HW MW SW UW	Field Strength Soil | Rock VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Groundwater	Samples	In-situ / Lab Testing
+200.40									
+200.20	0.20	TOPSOIL							
+200.00	0.40	SILT, minor clay; dark reddish brown. Stiff, moist, slightly plastic [RESIDUALLY WEATHERED BASALT]							P= 219 kPa
	1	SILT with clay and minor gravels to boulders; pinkish red with orange inclusions. Very stiff, moist, non to slightly plastic; gravels, coarse, boulders, highly weathered basalt, angular to subangular							P= 219 kPa
+199.20	1.20	COBBLES with silty matrix; red, brown and pink. Dense; cobbles, angular to subangular							P= UTP kPa
+198.40	2.00	Sharp rock interface. Basalt Lava Flow EOH @ 2.00 m							
	3								
	4								
	5								

SKETCH/PHOTOS:

SITE MAP



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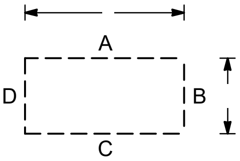
Shoring/Support:
Stability:



SAMPLES AND TESTING
- ● Grab Sample (Disturbed)
- Bulk Sample (Disturbed)
- ▼ Scala Penetrometer (blows/50mm)
- ﹀ Insitu Vane Shear Strength (kPa): P: Peak; R: Residual; UTP: Unable to penetrate
- Lab Testing: PSD: particle size dist. OMC: optimum moisture cont.; MDD: max dry density; Disp: dispersivity

GROUNDWATER
- ☒ None
- ☐ Slow Seep
- ☐ Rapid Inflow
- Water Strike
- Water Rise
- Time (minutes)

TERMINATION DUE TO
- ☐ Target depth
- ☐ Collapse
- ☒ Refusal
- ☐ Machine limit

Remarks

All dimensions in metres
Scale 1:50
Contractor: Far North Roading Ltd
Rig/Plant Used: Machine Excavator (15 tonne)
Logged by: AHL
Checked by: SRO

RILEY CONSULTANTS Engineers and Geologists

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Fax:

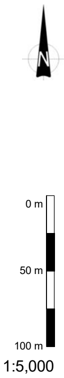
INSPECTION PIT LOG

Project: Northland Irrigation Scheme	Location: MN06 - Ohaeawai	Hole position: RILEY Dwg: 200249-102	No.: **TP05**
Job No.: 200240	Start Date: 07-05-20 Finish Date: 07-05-20	Ground Level (LINZ): 188.7m	Co-Ordinates (NZTM2000): E 1,677,840.0 N 6,087,772.0
Client: Te Tai Tokerau Water Trust	Hole Depth: 5.50 m		Sheet: 1 of 1

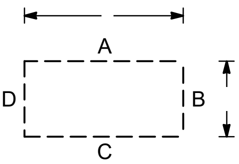
Elevation (m LINZ)	Depth (m)	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Weathering RS CW HW MW SW UW	Field Strength Soil | Rock VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Groundwater	Samples	In-situ / Lab Testing
+188.70									
+188.60	0.10	TOPSOIL							
+187.90	0.80	SILT; minor clay; dark reddish brown. Very stiff; moist; slightly plastic [RESIDUALLY WEATHERED BASALT] 0.50m Grades to trace cobbles to boulders, highly weathered basalt, subangular to subrounded							P= 172 kPa R= 50 kPa
+187.20	1.50	Clayey SILT; reddish brown with grey and pinkish white inclusions. Very stiff, moist, moderately plastic 1.30m Grades to orangish brown with light yellow specks							P= 94 kPa R= 16 kPa
+186.20	2.50	SILT with trace clay; light orange. Firm, wet, slightly plastic							P= 50 kPa R= 16 kPa P= 38 kPa R= 16 kPa
+183.70	5.00	SILT with trace clay and trace sand; pale pinkish grey with orange and white inclusions. Firm to stiff; wet to saturated, non to slightly plastic 4.00m Grades to purplish grey, saturated					▼		P= 75 kPa R= 13 kPa P= 91 kPa R= 25 kPa
+183.20	5.50	Highly weathered, black with orange staining, BASALT; strong. Recovered as cobbles and boulders, angular [BASALT LAVA FLOW]							
		EOH @ 5.50 m							

SKETCH/PHOTO

SITE MAP



Shoring/Support:
Stability:



SAMPLES AND TESTING
- ● Grab Sample (Disturbed)
- Bulk Sample (Disturbed)
- ▼ Scala Penetrometer (blows/50mm)
- ∨ Insitu Vane Shear Strength (kPa): P: Peak; R: Residual; UTP: Unable to penetrate
- Lab Testing: PSD: particle size dist. OMC: optimum moisture cont.; MDD: max dry density; Disp: dispersivity

GROUNDWATER
- ☐ None
- ☒ Slow Seep
- ☐ Rapid Inflow
- Water Strike
- Water Rise
- Time (minutes)

TERMINATION DUE TO
- ☐ Target depth
- ☐ Collapse
- ☒ Refusal
- ☐ Machine limit

Remarks

All dimensions in metres Scale 1:50	Contractor: Far North Roading Ltd	Rig/Plant Used: Machine Excavator (15 tonne)	Logged by: AHL	Checked by: SRO

RILEY CONSULTANTS
Engineers and Geologists

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Fax:

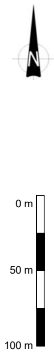
INSPECTION PIT LOG

Project: Northland Irrigation Scheme	Location: MN06 - Ohaeawai	Hole position: RILEY Dwg: 200249-102	No.: **TP06**
Job No.: 200240	Start Date: 07-05-20 Finish Date: 07-05-20	Ground Level (LINZ): 186.6m	Co-Ordinates (NZTM2000): E 1,677,875.0 N 6,087,771.0
Client: Te Tai Tokerau Water Trust	Hole Depth: 4.00 m		Sheet: 1 of 1

Elevation (m LINZ)	Depth (m)	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Weathering RS CW HW MW SW UW	Field Strength Soil | Rock VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Groundwater	Samples	In-situ / Lab Testing
+186.60									
+186.40	0.20	TOPSOIL							
+185.40	1.20	SILT, minor clay; dark reddish brown. Very stiff, moist, slightly plastic [RESIDUALLY WEATHERED BASALT]							P= 175 kPa R= 63 kPa
+184.20	2.40	SILT with some clay; pinkish grey with light yellow specks. Firm to stiff, wet, slightly to moderately plastic							P= 56 kPa R= 34 kPa P= 159 kPa R= 9 kPa
+183.10	3.50	SILT with minor clay and minor cobbles to boulders, trace sand; pinksih grey with orange and black staining. Very stiff, wet, non to slightly plastic; cobbles and boulders, highly to completely weathered basalt; sand, coarse					▼		P= UTP kPa
+182.60	4.00	Highly weathered BASALT; strong. Recovered as cobbles and boulders, angular to subangular; orange, black and brown [BASALT LAVA FLOW]							
		EOH @ 4.00 m							

SKETCH/PHOTOS:

SITE MAP



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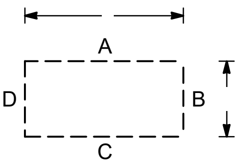
Shoring/Support:
Stability:



SAMPLES AND TESTING
- ● Grab Sample (Disturbed)
- Bulk Sample (Disturbed)
- ▼ Scala Penetrometer (blows/50mm)
- ∨ Insitu Vane Shear Strength (kPa): P: Peak; R: Residual; UTP: Unable to penetrate
- Lab Testing: PSD: particle size dist. OMC: optimum moisture cont.; MDD: max dry density; Disp: dispersivity

GROUNDWATER
- ☐ None
- ☒ Slow Seep
- ☐ Rapid Inflow
- ▼ Water Strike
- Water Rise
- ▽ Time (minutes)

TERMINATION DUE TO
- ☐ Target depth
- ☐ Collapse
- ☒ Refusal
- ☐ Machine limit

Remarks

All dimensions in metres Scale 1:50	Contractor: Far North Roading Ltd	Rig/Plant Used: Machine Excavator (15 tonne)	Logged by: AHL	Checked by: SRO

RILEY CONSULTANTS Engineers and Geologists

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Fax:

INSPECTION PIT LOG

Project: Northland Irrigation Scheme	Location: MN06 - Ohaeawai	Hole position: RILEY Dwg: 200249-102	No.: TP07
Job No.: 200240	Start Date: 07-05-20 Finish Date: 07-05-20	Ground Level (LINZ): 201.4m	Co-Ordinates (NZTM2000): E 1,677,961.8 N 6,087,790.2
Client: Te Tai Tokerau Water Trust	Hole Depth: 4.50 m		Sheet: 1 of 1

Elevation (m LINZ)	Depth (m)	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Weathering RS CW HW MW SW UW	Field Strength Soil VS/VL S/L F/MD St/D VSt/VD H/EW | Rock VW W MS S VS ES	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Groundwater	Samples	In-situ / Lab Testing
+201.40									
+201.30	0.10	TOPSOIL							
+200.90	0.50	SILT with minor clay; brown. Stiff, moist, slightly plastic [RESIDUALLY WEATHERED BASALT]							P= 125 kPa R= 22 kPa
	1	Clayey SILT; light pinkish grey. Very stiff; moist; moderately plastic							P= 219 kPa
+199.90	1.50	Silty CLAY; light pinkish grey. Very stiff, moist, moderately plastic							P= 219 kPa
+199.40	2 / 2.00	SILT with some clay; light pinkish orange. Very stiff, moist, slightly plastic							P= 188 kPa R= 63 kPa
	3	3.00m Grades to minor clay, pinkish grey with white specks, moist to wet							P= 219 kPa
	4	4.00m Grades to trace gravel, fine to coarse, angular to subangular, highly weathered basalt							
+196.90	4.50	EOH @ 4.50 m							
	5								

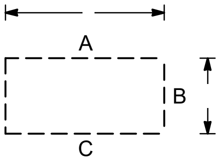
SKETCH/PHOTOS:

SITE MAP

N

0 m
50 m
100 m
1:5,000

Shoring/Support:
Stability:



SAMPLES AND TESTING
- ● Grab Sample (Disturbed)
- Bulk Sample (Disturbed)
- ▼ Scala Penetrometer (blows/50mm)
- ∨ Insitu Vane Shear Strength (kPa): P: Peak; R: Residual; UTP: Unable to penetrate
- Lab Testing: PSD: particle size dist. OMC: optimum moisture cont.; MDD: max dry density; Disp: dispersivity

GROUNDWATER
- ☒ None
- ☐ Slow Seep
- ☐ Rapid Inflow
- Water Strike
- Water Rise
- Time (minutes)

TERMINATION DUE TO
- ☐ Target depth
- ☐ Collapse
- ☐ Refusal
- ☒ Machine limit

Remarks

All dimensions in metres Scale 1:50	Contractor: Far North Roading Ltd	Rig/Plant Used: Machine Excavator (15 tonne)	Logged by: AHL	Checked by: SRO

RILEY CONSULTANTS Engineers and Geologists

RILEY Consultants Ltd
Level 2, 22 Moorhouse Ave
Addington, Christchurch, 8024
Tel: +64 3 379 4402
Fax:

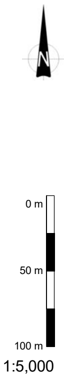
INSPECTION PIT LOG

Project: Northland Irrigation Scheme	Location: MN06 - Ohaeawai	Hole position: RILEY Dwg: 200249-102	No.: **TP08**
Job No.: 200240	Start Date: 08-05-20 Finish Date: 08-05-20	Ground Level (LINZ): 197.9m	Co-Ordinates (NZTM2000): E 1,677,852.0 N 6,087,631.0
Client: Te Tai Tokerau Water Trust	Hole Depth: 5.50 m		Sheet: 1 of 1

Elevation (m LINZ) +197.90	Depth (m)	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Weathering RS CW HW MW SW UW	Field Strength Soil: VS/VL S/L F/MD St/D VSt/VD H/EW Rock: VW W MS S VS ES	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Groundwater	Samples	In-situ / Lab Testing
+197.70	0.20	TOPSOIL							
		Clayey SILT; dark reddish brown. Very stiff, moist; moderately plastic [RESIDUALLY WEATHERED BASALT]							P= 219 kPa P= 172 kPa R= 44 kPa P= 141 kPa R= 56 kPa P= 134 kPa R= 63 kPa
+195.40	2.50	SILT with minor clay; dark orangish reddish brown. Very stiff, moist, slightly plastic							
+194.90	3.00	SILT with minor clay and cobbles to boulders; dark reddish brown with black inclusions. Very stiff, moist, slightly plastic; cobbles to boulders, highly weathered basalt, angular to sub rounded 3.50m Grades to wet							
+192.40	5.50	EOH @ 5.50 m							

SKETCH/PHOTO

SITE MAP



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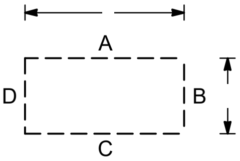
Shoring/Support:
Stability:



SAMPLES AND TESTING
- ● Grab Sample (Disturbed)
- Bulk Sample (Disturbed)
- ▼ Scala Penetrometer (blows/50mm)
- ∨ Insitu Vane Shear Strength (kPa): P: Peak; R: Residual; UTP: Unable to penetrate
- Lab Testing: PSD: particle size dist. OMC: optimum moisture cont.; MDD: max dry density; Disp: dispersivity

GROUNDWATER
- ☒ None
- ☐ Slow Seep
- ☐ Rapid Inflow
- Water Strike
- Water Rise
- Time (minutes)

TERMINATION DUE TO
- ☐ Target depth
- ☐ Collapse
- ☐ Refusal
- ☒ Machine limit

Remarks

All dimensions in metres Scale 1:50	Contractor: Far North Roading Ltd	Rig/Plant Used: Machine Excavator (15 tonne)	Logged by: AHL	Checked by: SRO

RILEY Consultants Ltd
Level 2, 22 Moorhouse Ave
Addington, Christchurch, 8024
Tel: +64 3 379 4402
Fax:

INSPECTION PIT LOG

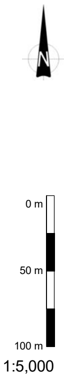
Project: Northland Irrigation Scheme
Location: MN06 - Ohaeawai
Hole position: RILEY Dwg: 200249-102
No.: **TP09**
Job No.: 200240
Start Date: 08-05-20
Finish Date: 08-05-20
Ground Level (LINZ): 202.7m
Co-Ordinates (NZTM2000): E 1,677,664.7 N 6,087,685.3
Client: Te Tai Tokerau Water Trust
Hole Depth: 4.10 m
Sheet: 1 of 1

Elevation (m LINZ) +202.70	Depth (m)	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Weathering RS CW HW MW SW UW	Field Strength Soil / Rock VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Groundwater	Samples	In-situ / Lab Testing
+202.50	0.20	TOPSOIL							
+202.20	0.50	SILT, minor clay; light greyish brown. Very stiff, moist, slightly plastic [RESIDUALLY WEATHERED BASALT]							
+201.20	1.50	Silty CLAY; puple grey with white inclusions. Very stiff, moist, moderately plastic 1.20m Grades to some silt, moderately to highly plastic							P= 219 kPa P= 172 kPa R= 63 kPa
+199.70	3.00	SILT with some clay; dark purple grey with white inclusions. Very stiff, moist slightly plastic							P= 219 kPa P= 188 kPa R= 50 kPa P= 53 kPa R= 28 kPa
+198.90	3.80	SILT with minor clay; dark purple grey with white inclusions. Firm, moist to wet, slightly plastic							
+198.60	4.10	Completely to highly weathered, puplish grey BASALT. Very weak to weak. [BASALT LAVA FLOW]							P= UTP kPa
		EOH @ 4.10 m							

Depth scale: 1, 2, 3, 4, 5

SKETCH/PHOTO

SITE MAP



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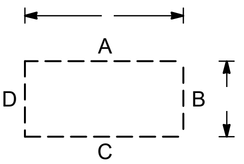
Shoring/Support:
Stability:



SAMPLES AND TESTING
- ● Grab Sample (Disturbed)
- Bulk Sample (Disturbed)
- ▼ Scala Penetrometer (blows/50mm)
- ∨ Insitu Vane Shear Strength (kPa): P: Peak; R: Residual; UTP: Unable to penetrate
- Lab Testing: PSD: particle size dist. OMC: optimum moisture cont.; MDD: max dry density; Disp: dispersivity

GROUNDWATER
- ☒ None
- ☐ Slow Seep
- ☐ Rapid Inflow
- Water Strike
- Water Rise
- Time (minutes)

TERMINATION DUE TO
- ☐ Target depth
- ☐ Collapse
- ☒ Refusal
- ☐ Machine limit

Remarks

All dimensions in metres
Scale 1:50
Contractor: Far North Roading Ltd
Rig/Plant Used: Machine Excavator (15 tonne)
Logged by: AHL
Checked by: SRO

RILEY Consultants Ltd
Level 2, 22 Moorhouse Ave
Addington, Christchurch, 8024
Tel: +64 3 379 4402
Fax:

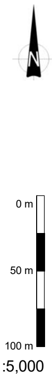
INSPECTION PIT LOG

Project: Northland Irrigation Scheme	Location: MN06 - Ohaeawai	Hole position: RILEY Dwg: 200249-102	No.: **TP09A**
Job No.: 200240	Start Date: 08-05-20 Finish Date: 08-05-20	Ground Level (LINZ): 194.2m	Co-Ordinates (NZTM2000): E 1,677,681.5 N 6,087,726.1
Client: Te Tai Tokerau Water Trust	Hole Depth: 4.10 m		Sheet: 1 of 1

Elevation (m LINZ) +194.20	Depth (m)	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Weathering RS CW HW MW SW UW	Field Strength Soil | Rock VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Groundwater	Samples	In-situ / Lab Testing
+194.00	0.20	TOPSOIL							
+193.70	0.50	SILT with minor clay; light brown grey. Very stiff, moist, slightly plastic [RESIDUALLY WEATHERED BASALT]							P= 172 kPa R= 50 kPa
+192.60	1.60	Silty CLAY; light brown and purple grey mixed. Very stiff, moist, moderately plastic							P= 97 kPa R= 63 kPa P= 50 kPa R= 38 kPa
+191.70	2.50	SILT with trace clay, trace gravels and trace cobbles; light brown with dark orange inclusions. Very stiff, moist to wet, non plastic; gravel and boulders, completely to highly weathered basalt							P= 100 kPa R= 20 kPa
+190.10	4.10	SILT with trace gravel and trace clay; orangish, pinkish grey with white inclusions. Very stiff, to hard, wet, non plastic [COMPLETELY WEATHERED BASALT]							P= UTP kPa
		Rock interface at 4.1m. Difficult to excavate. Recovered as completely to highly weathered basalt cobbles to boulders. EOH @ 4.10 m							

SKETCH/PHOTOS:

SITE MAP



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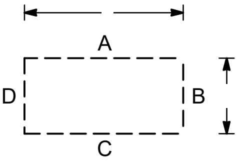
Shoring/Support:
Stability:



SAMPLES AND TESTING
● Grab Sample (Disturbed)
Bulk Sample (Disturbed)
▼ Scala Penetrometer (blows/50mm)
Insitu Vane Shear Strength (kPa):
P: Peak; R: Residual;
UTP: Unable to penetrate
Lab Testing: PSD: particle size dist.
OMC: optimum moisture cont.; MDD: max dry density; Disp: dispersivity

GROUNDWATER
☒ None
☐ Slow Seep
☐ Rapid Inflow
Water Strike
Water Rise
Time (minutes)

TERMINATION DUE TO
☐ Target depth
☐ Collapse
☒ Refusal
☐ Machine limit

Remarks

All dimensions in metres Scale 1:50	Contractor: Far North Roading Ltd	Rig/Plant Used: Machine Excavator (15 tonne)	Logged by: AHL	Checked by: SRO

RILEY Consultants Ltd
Level 2, 22 Moorhouse Ave
Addington, Christchurch, 8024
Tel: +64 3 379 4402
Fax:

INSPECTION PIT LOG

Project: Northland Irrigation Scheme	Location: MN06 - Ohaeawai	Hole position: RILEY Dwg: 200249-102	No.: **TP10**
Job No.: 200240	Start Date: 08-05-20 Finish Date: 08-05-20	Ground Level (LINZ): 202.9m	Co-Ordinates (NZTM2000): E 1,677,373.0 N 6,087,757.0
Client: Te Tai Tokerau Water Trust	Hole Depth: 4.60 m	Sheet: 1 of 1	

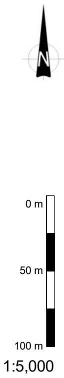
Elevation (m LINZ) +202.90	Depth (m)	Geological Description (refer to separate Geotechnical and Geological Information sheet for further information)	Legend	Weathering	Field Strength	Defect Description (type, orientation, spacing, roughness, persistence aperture, infilling etc)	Groundwater	Samples	In-situ / Lab Testing
+202.70	0.20	TOPSOIL							
+201.70	1.20	SILT with some clay; orangish brown. Very stiff to hard, moist, slightly plastic [ASH]							P= 219 kPa P= 219 kPa
+200.60	2.30	SILT with minor clay; light brown. Stiff, moist, slightly plastic							P= 97 kPa R= 50 kPa
+199.70	3.20	Clayey SILT; whitish brown. Firm, moist to wet, moderately plastic							P= 50 kPa R= 38 kPa P= 69 kPa R= 50 kPa
+198.60	4.30	SILT with trace clay and trace sand; light bluish grey with orange inclusions. Stiff, wet, non to slightly plastic 4.00m Grades to light purplish grey							P= UTP kPa
+198.30	4.60	Slightly weathered, reddish brown TUFF. Very weak to weak. Recovered as sandy GRAVEL, scoria, ash and lapilli [WELDED TUFF]							P= UTP kPa
		EOH @ 4.60 m							

Weathering: RS CW HW MW SW UW

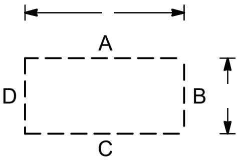
Field Strength: Soil | Rock: VS/VL S/L F/MD St/D VSt/VD H/EW VW W MS S VS ES

SKETCH/PHOTO

SITE MAP



Shoring/Support:
Stability:



SAMPLES AND TESTING
● Grab Sample (Disturbed)
Bulk Sample (Disturbed)
▼ Scala Penetrometer (blows/50mm)
Insitu Vane Shear Strength (kPa):
P: Peak; R: Residual;
UTP: Unable to penetrate
Lab Testing: PSD: particle size dist.
OMC: optimum moisture cont.; MDD: max dry density; Disp: dispersivity

GROUNDWATER
☒ None
☐ Slow Seep
☐ Rapid Inflow
Water Strike
Water Rise
Time (minutes)

TERMINATION DUE TO
☐ Target depth
☐ Collapse
☐ Refusal
☒ Machine limit

Remarks

All dimensions in metres Scale 1:50	Contractor: Far North Roading Ltd	Rig/Plant Used: Machine Excavator (15 tonne)	Logged by: AHL	Checked by: SRO

RILEY AGS 3_1 NZ LIB 13.GLB Log RILEY CHCH TP 200240 MN06 TPS.GPJ <<DrawingFile>> 13/08/2020 15:52 Produced by gINT Professional

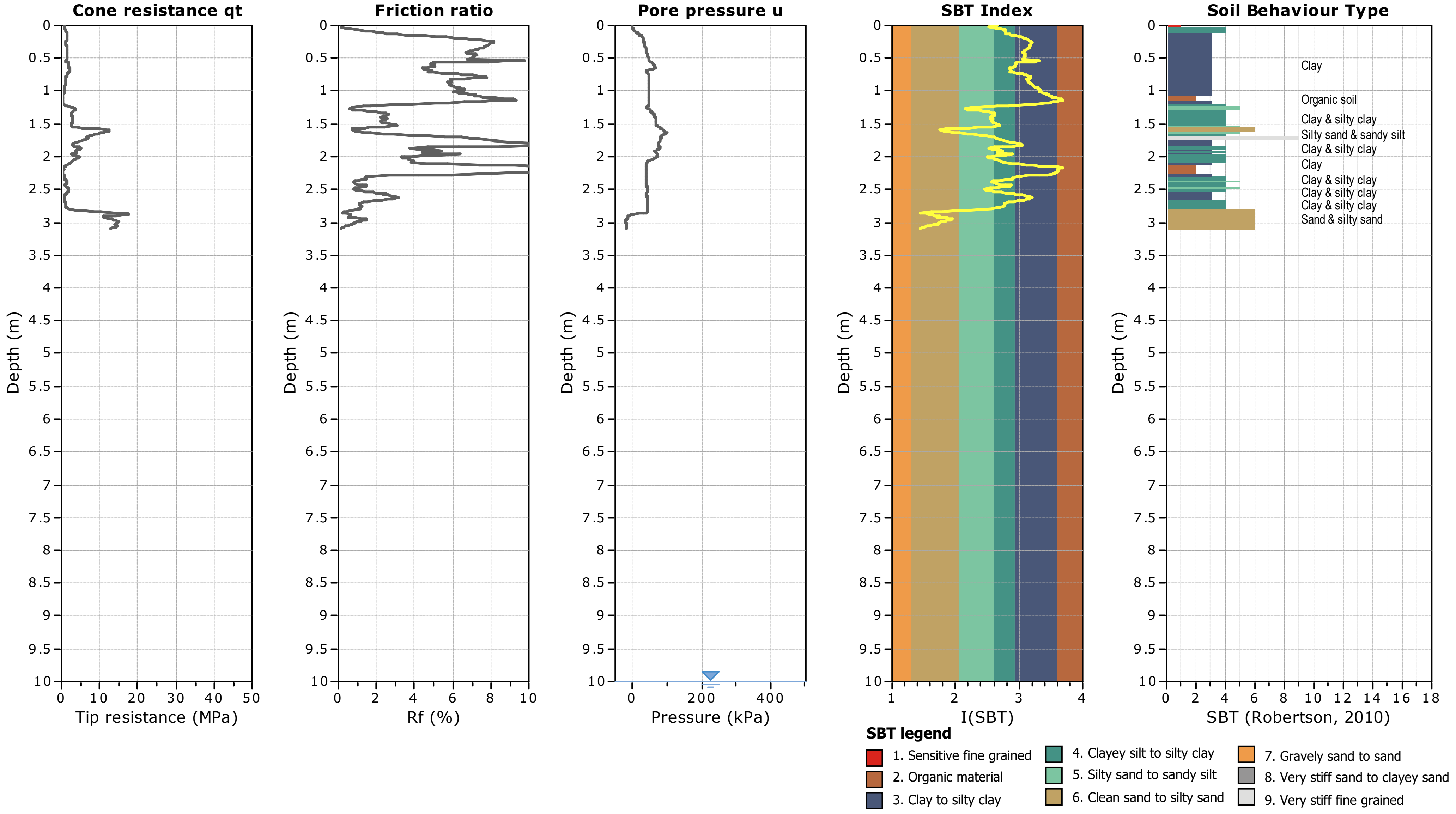
APPENDIX B

CPT Data

Riley Consultants Ltd
4 Fred Thomas Drive, Takapuna
www.riley.co.nz

CPT: CPT01
Total depth: 3.09 m, Date: 7/05/2020
Surface Elevation: 202.20 m
Coords: X:1677545.90, Y:6087963.70
Cone Type: Nova Cone 100MPa
Cone Operator: Underground Investigation Ltd

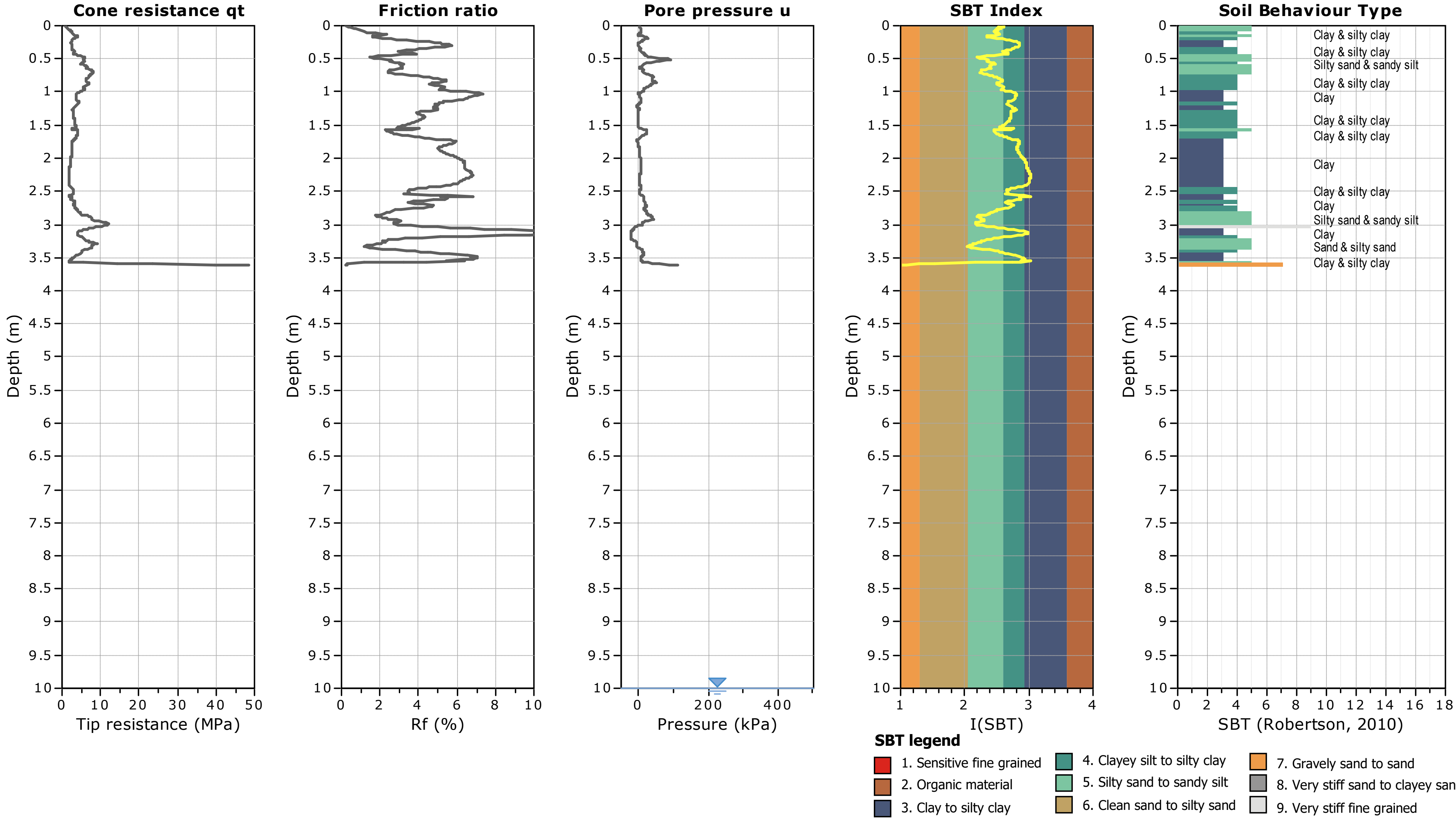
Project: **RILEY Ref - 200240**
Location: **MN06**



Riley Consultants Ltd
4 Fred Thomas Drive, Takapuna
www.riley.co.nz

Project: **RILEY Ref - 200240**
Location: **MN06**

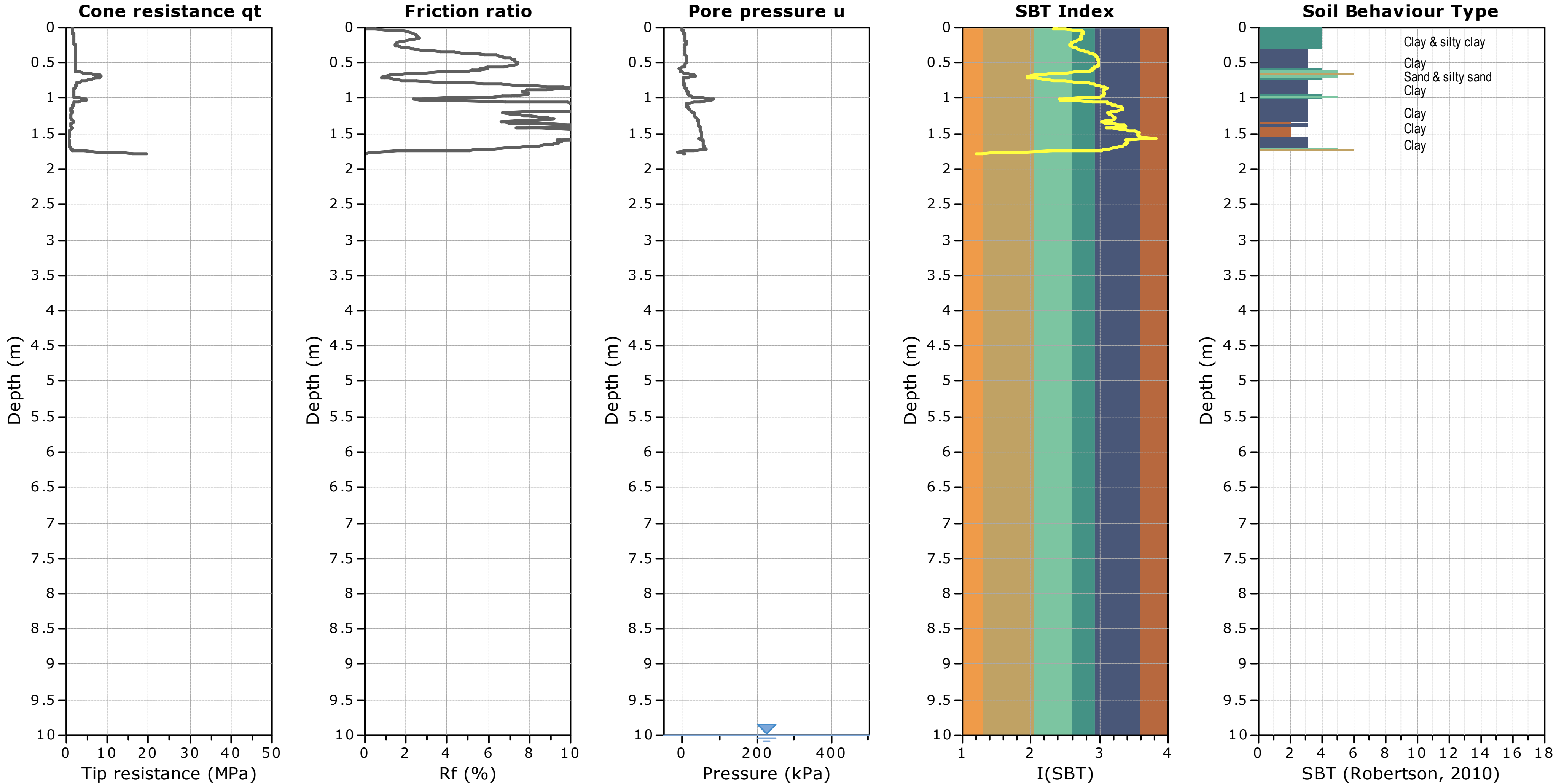
CPT: CPT02
Total depth: 3.62 m, Date: 7/05/2020
Surface Elevation: 201.30 m
Coords: X:1677786.20, Y:6087831.90
Cone Type: Nova Cone 100MPa
Cone Operator: Underground Investigation Ltd



Riley Consultants Ltd
4 Fred Thomas Drive, Takapuna
www.riley.co.nz

CPT: CPT03
Total depth: 1.79 m, Date: 7/05/2020
Surface Elevation: 187.10 m
Coords: X:1677852.60, Y:6087795.10
Cone Type: Nova Cone 100MPa
Cone Operator: Underground Investigation Ltd

Project: **RILEY Ref - 200240**
Location: **MN06**



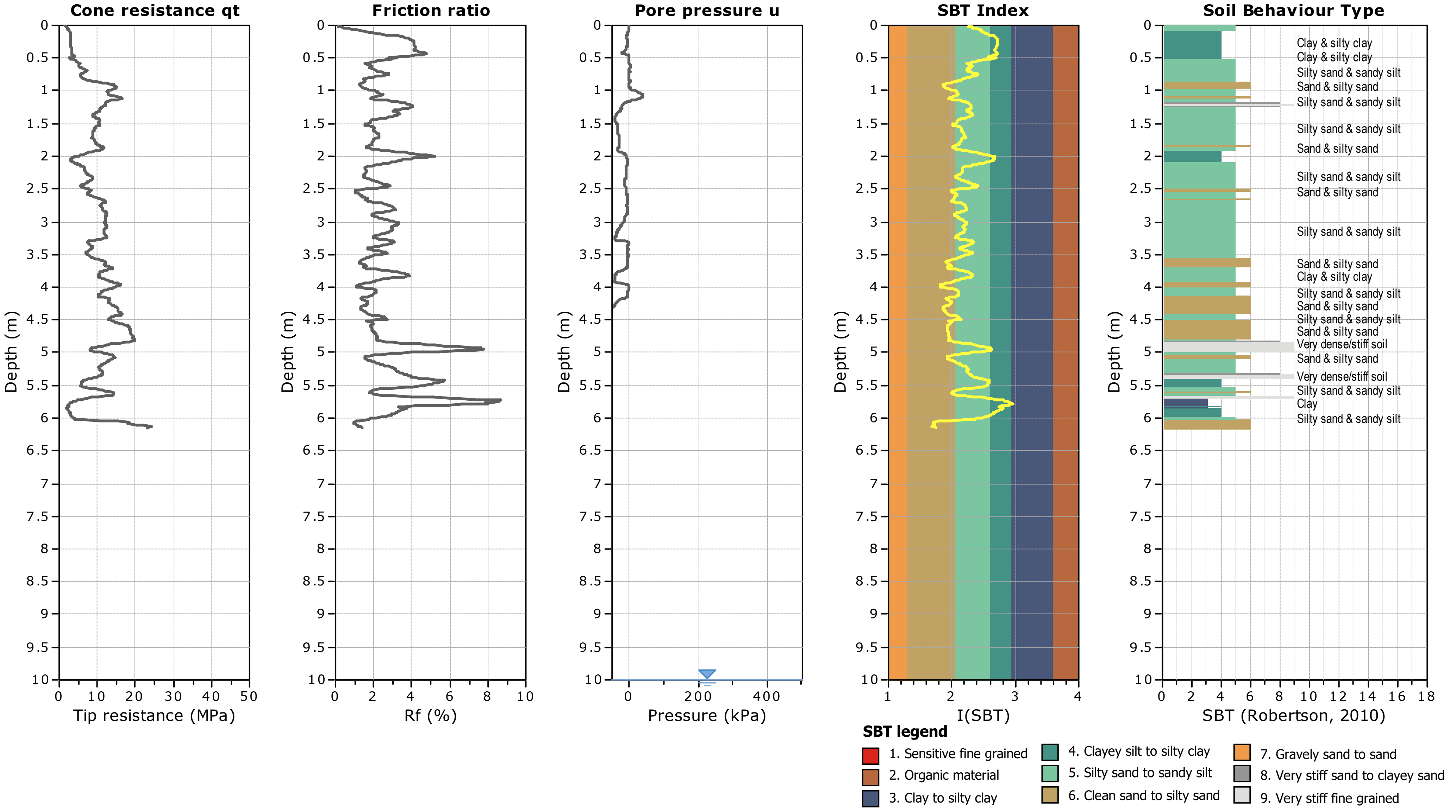
SBT legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty clay
- 🟩 5. Silty sand to sandy silt
- 🟨 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬜ 8. Very stiff sand to clayey sand
- ⬜ 9. Very stiff fine grained

Riley Consultants Ltd
4 Fred Thomas Drive, Takapuna
www.riley.co.nz

Project: **RILEY Ref - 200240**
Location: **MN06**

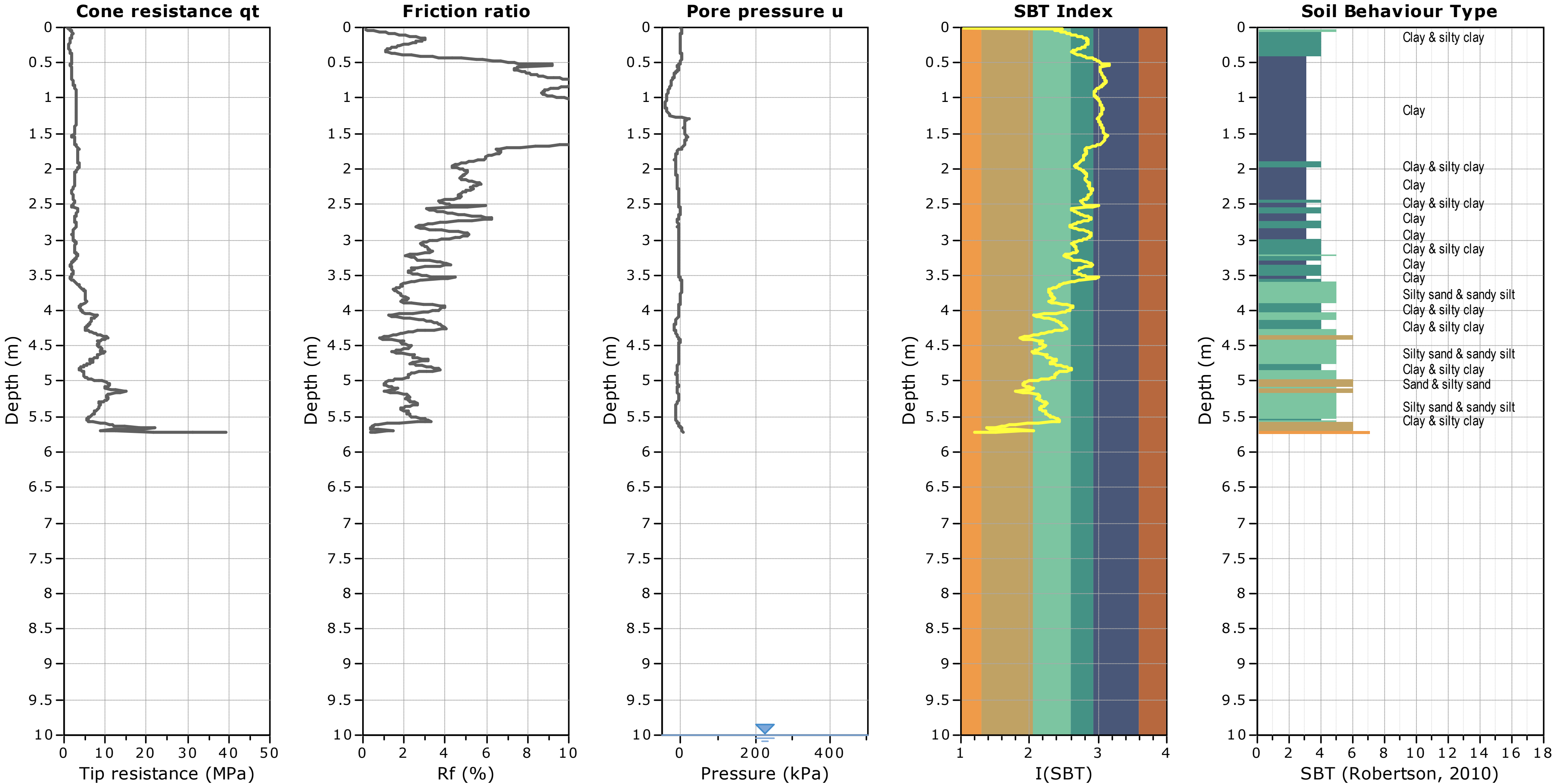
CPT: CPT04
Total depth: 6.14 m, Date: 7/05/2020
Surface Elevation: 192.40 m
Coords: X:1677898.80, Y:6087763.50
Cone Type: Nova Cone 100MPa
Cone Operator: Underground Investigation Ltd



Riley Consultants Ltd
4 Fred Thomas Drive, Takapuna
www.riley.co.nz

Project: **RILEY Ref - 200240**
Location: **MN06**

CPT: CPT05
Total depth: 5.73 m, Date: 7/05/2020
Surface Elevation: 197.90 m
Coords: X:1677895.60, Y:6087732.20
Cone Type: Nova Cone 100MPa
Cone Operator: Underground Investigation Ltd

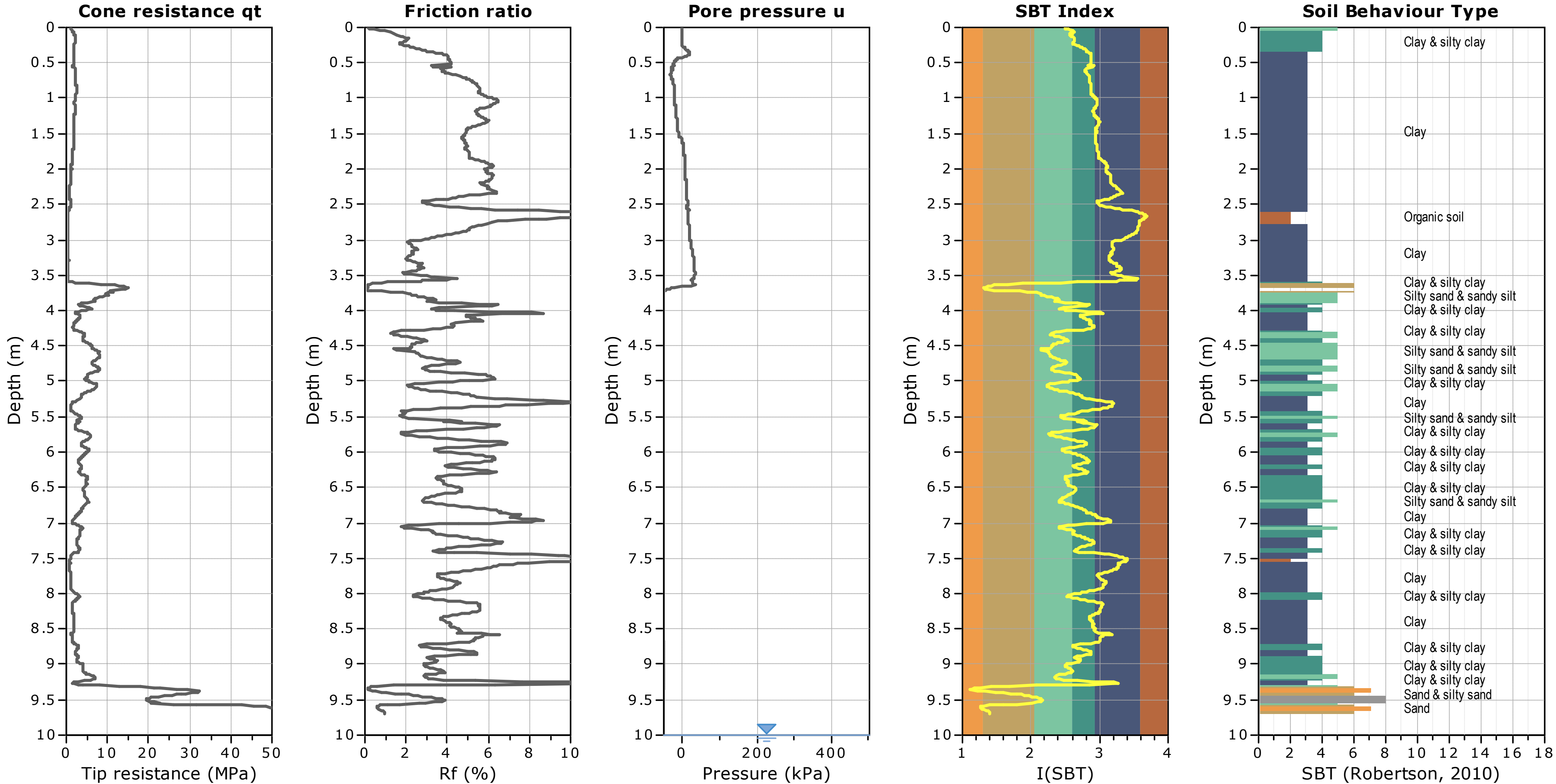


SBT legend

🟥	1. Sensitive fine grained
🟫	2. Organic material
🟦	3. Clay to silty clay
🟩	4. Clayey silt to silty clay
🟩	5. Silty sand to sandy silt
🟨	6. Clean sand to silty sand
🟧	7. Gravely sand to sand
⬜	8. Very stiff sand to clayey sand
⬜	9. Very stiff fine grained

CPT: CPT06
Total depth: 9.70 m, Date: 7/05/2020
Surface Elevation: 202.90 m
Coords: X:1677890.70, Y:6087816.60
Cone Type: Nova Cone 100MPa
Cone Operator: Underground Investigation Ltd

Project: **RILEY Ref - 200240**
Location: **MN06**



SBT legend

🟥 1. Sensitive fine grained
🟫 2. Organic material
🟦 3. Clay to silty clay
🟩 4. Clayey silt to silty clay
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬜ 8. Very stiff sand to clayey sand
⬜ 9. Very stiff fine grained

APPENDIX C

RILEY Dwgs:
200240-0 and
200240-101 to -108

TE TAI TOKERAU WATER TRUST

TE RUAOTEHAUHAU WATER STORAGE RESERVOIR SITE

DRAWING LIST - SEPTEMBER 2020

DWG. No.	TITLE	REV.
200240/3-0	DRAWING LIST & LOCATION PLAN	1
200240/3-101	GEOMORPHIC AND GEOLOGIC MAP	1
200240/3-102	SITE PLAN AND INVESTIGATIONS	1
200240/3-103	GEOTECHNICAL CROSS SECTION B	1
200240/3-104	GEOTECHNICAL LONG SECTION A	1
200240/3-105	DAM CROSS SECTION AND LONG SECTION	1
200240/3-106	CONDUIT DETAILS	1
200240/3-107	SPILLWAY DETAILS	1
200240/3-108	TEMPORARY FLOOD CONTROL WORKS DURING CONSTRUCTION	1
200240/2-200	DOWNSTREAM FLOODPLAIN OVERVIEW	1
200240/2-201	SUNNY DAY BREACH - PEAK LEVELS (AREA 1)	1
200240/2-202	SUNNY DAY BREACH - PEAK LEVELS (AREA 2)	1
200240/2-203	SUNNY DAY BREACH - PEAK DEPTHS (AREA 1)	1
200240/2-204	SUNNY DAY BREACH - PEAK DEPTHS (AREA 2)	1
200240/2-205	SUNNY DAY BREACH - PEAK DEPTH VELOCITY PRODUCT (AREA 1)	1
200240/2-206	SUNNY DAY BREACH - PEAK DEPTH VELOCITY PRODUCT (AREA 2)	1
200240/3-210	CATCHMENT PLAN - AERIAL BACKGROUND	1
200240/3-211	CATCHMENT PLAN - GEOLOGY BACKGROUND	1

NOTE: MAP SOURCED FROM LINZ

SITE LOCATION

SCALE 1: 15 000

SCALE 1: 15000

0 150 300 450 600 900 (m)

FOR CONSENT

REV	DATE	ISSUE	BY
1		FOR CONSENT	MP

DESIGN: EM
DES CHECK: SMM
DRAWN: MP
CAD CHECK: JM
APPROVED FOR ISSUE: S VAUGHAN
DATE DRAWN: AUG. 2020
ISSUE DATE: 01 / 09 / 20

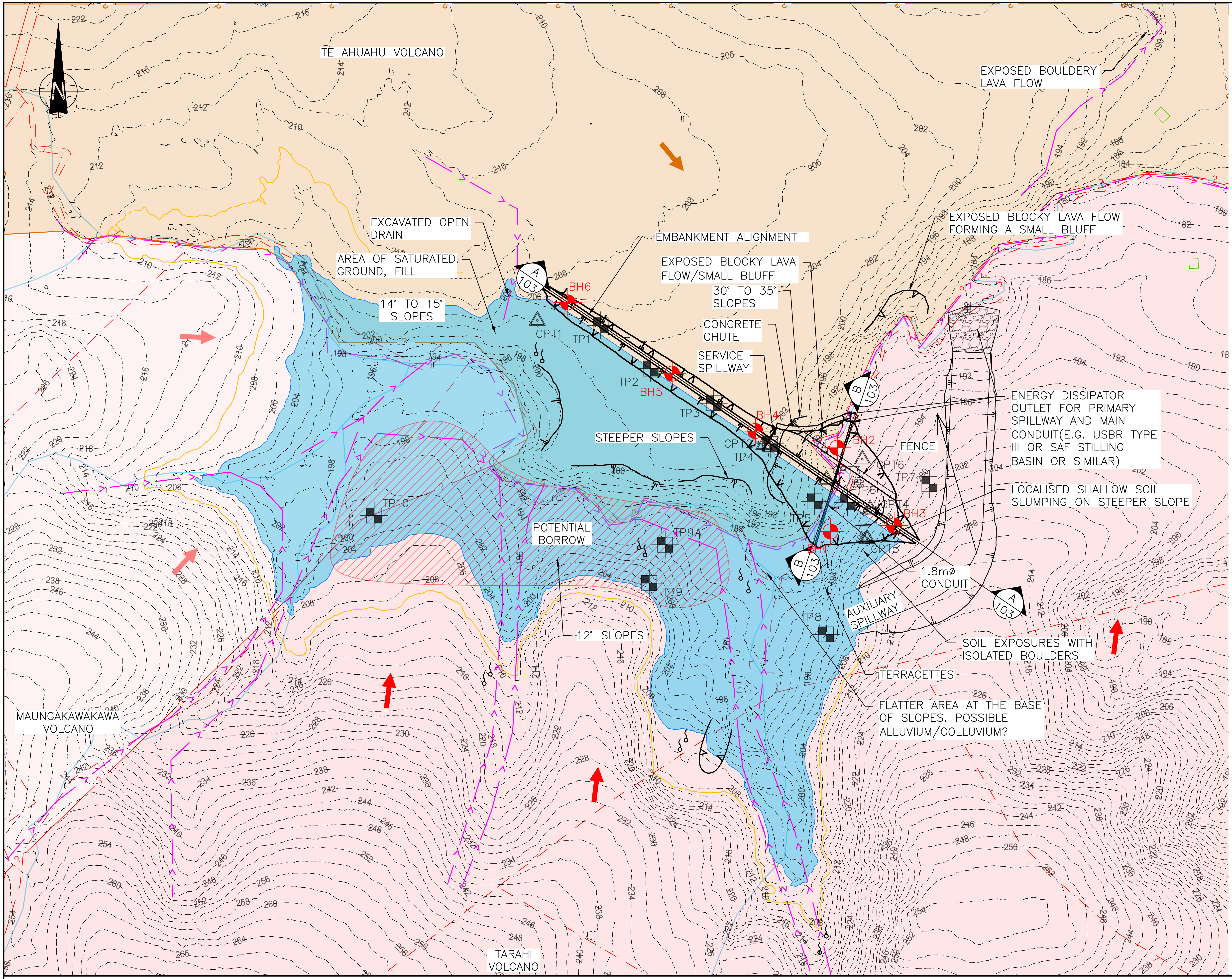
RILEY CONSULTANTS
www.riley.co.nz

WILLIAMSON WATER & LAND ADVISORY

TE TAI TOKERAU WATER TRUST
Nga Puna Wai He koha Oranga Tangata He koha Oranga Whenua!
The Springs of Water. A gift of life to our people. A gift of life to our land!

CLIENT: TE TAI TOKERAU WATER TRUST
ADDRESS: NORTHLAND WATER STORAGE AND USE PROJECT
PROJECT: TE RUAOTEHAUHAU WATER STORAGE RESERVOIR SITE
SHEET TITLE: DRAWING LIST & LOCATION PLAN

CADFILE: 200240_3-0.dwg
SCALE (A3): 1:10,000
ORIG. SHEET SIZE: A3
DRAWING No.: 200240/3-0
REV.: 1



LEGEND

- - - -	2m CONTOURS
— — —	PROPERTY BOUNDARY
— < —	STREAM CHANNEL
—V—	SCARP
○~	SPRING
△ CPT1	CPT LOCATION
▦ TP1	TEST PIT LOCATION
⊕ BH1	PROPOSED BOREHOLE LOCATION
→	INFERRED BASALTIC LAVA FLOW FROM MAUNGAKAWAKAWA VOLCANO
→	INFERRED BASALTIC LAVA FLOW FROM TARAHI VOLCANO
→	INFERRED BASALTIC LAVA FLOW FROM TE AHUAHU VOLCANO
🟦	RESERVOIR FULL SUPPLY LEVEL
——	MAXIMUM INUNDATION LEVEL
⬭	DAM EMBANKMENT

REFERENCE NOTES:

1. CONTOURS AND AERIAL PHOTO SOURCED FROM 2019 NORTHLAND REGIONAL COUNCIL LIDAR.
2. MAXIMUM INUNDATION AREA ILLUSTRATES THE AREA LIKEY TO BE INNUNDATED ASSUMING A NOMINAL 20m BUFFER.

40 0 80 160m
SCALE 1:4000

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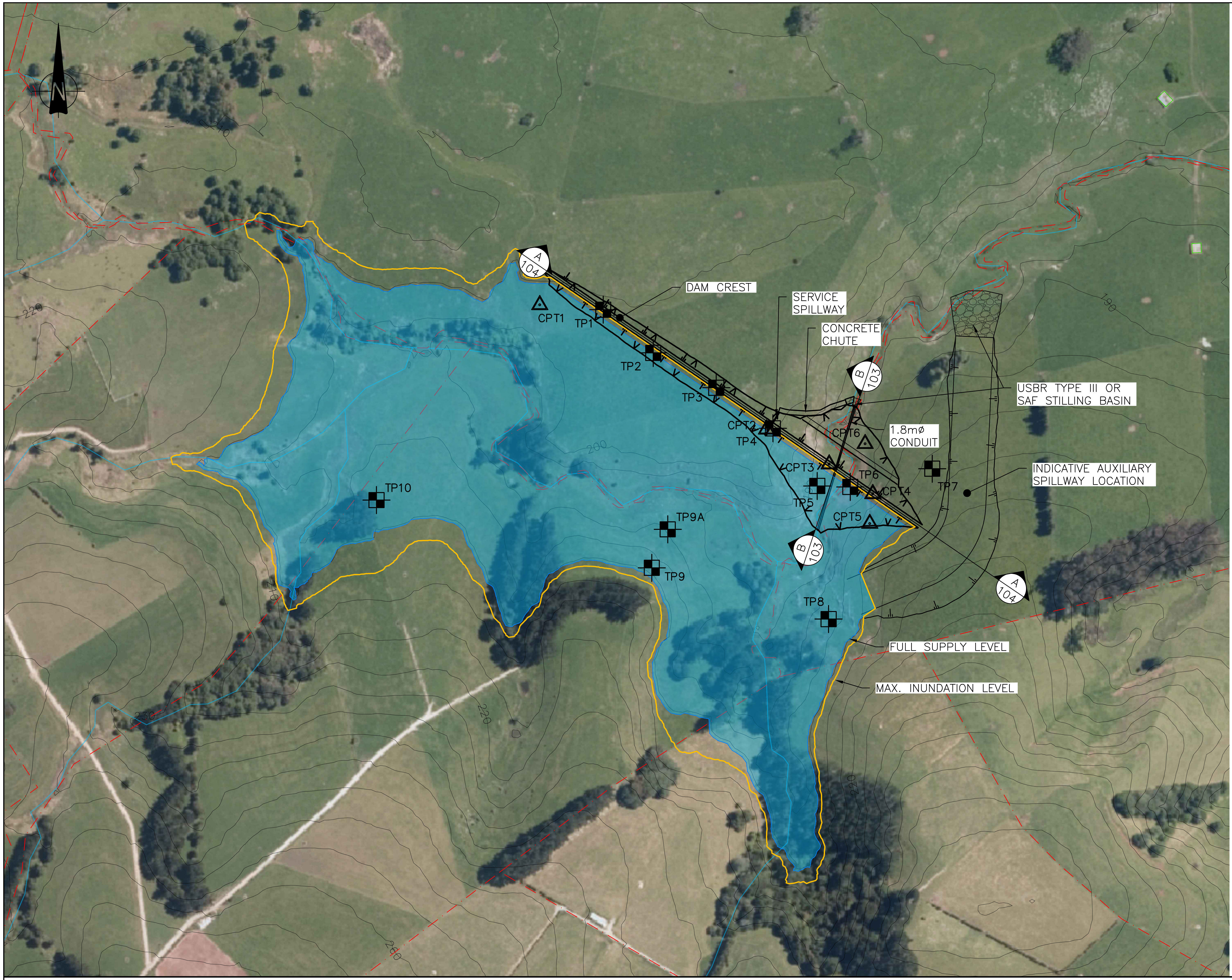

LEGEND

───	5m CONTOURS
─ · ─	PROPERTY BOUNDARY
───	STREAM CHANNELS
───	MAXIMUM INUNDATION LEVEL
🟦	INUNDATION TO FULL SUPPLY LEVEL (FSL)
TP1	TEST PIT
CPT1	CONE PENETROMETER TEST

REFERENCE NOTES:

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SHEET TITLE	SITE PLAN AND INVESTIGATIONS

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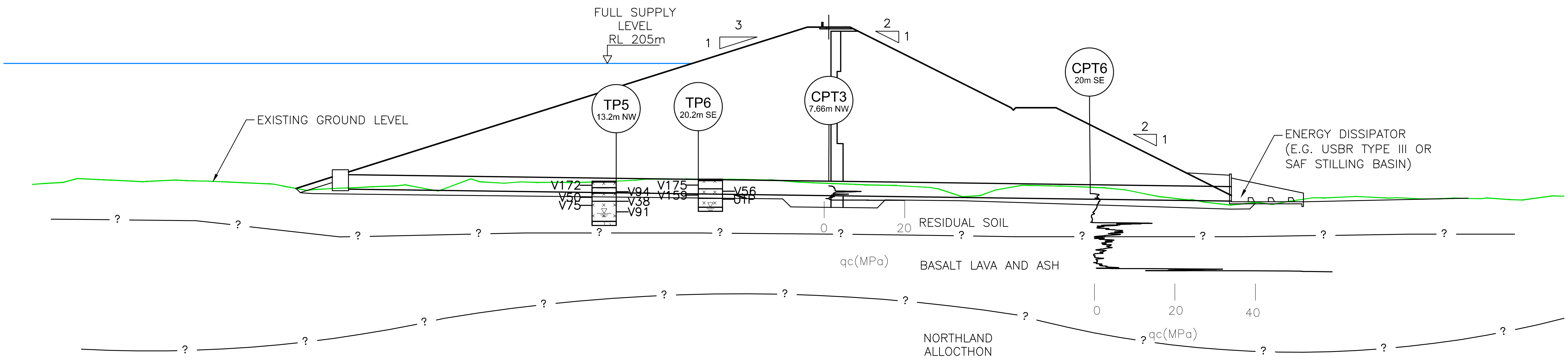

SECTION B 102 DAM SECTION AT MAXIMUM HEIGHT

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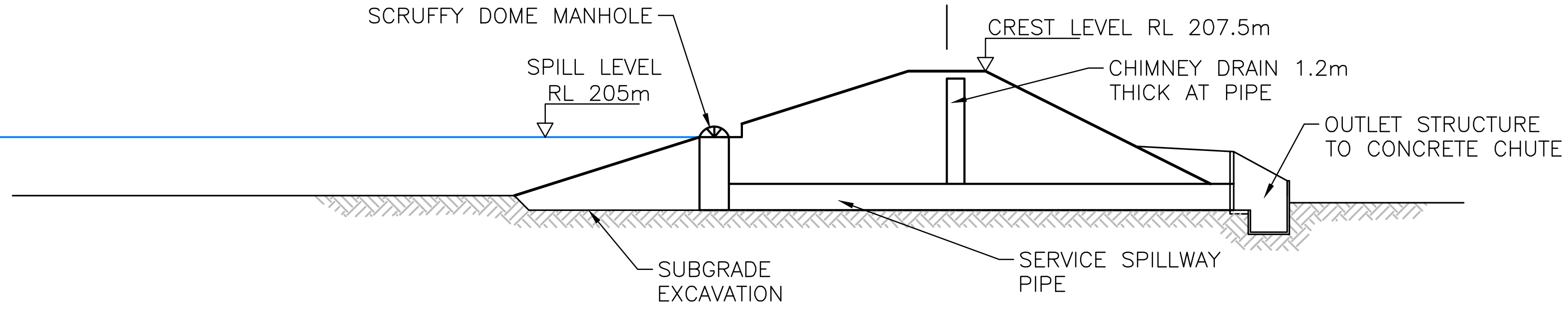

INDICATIVE SERVICE SPILLWAY DETAILS

SCALE 1: 500

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SHEET TITLE: GEOTECHNICAL CROSS SECTION B & SERVICE SPILLWAY

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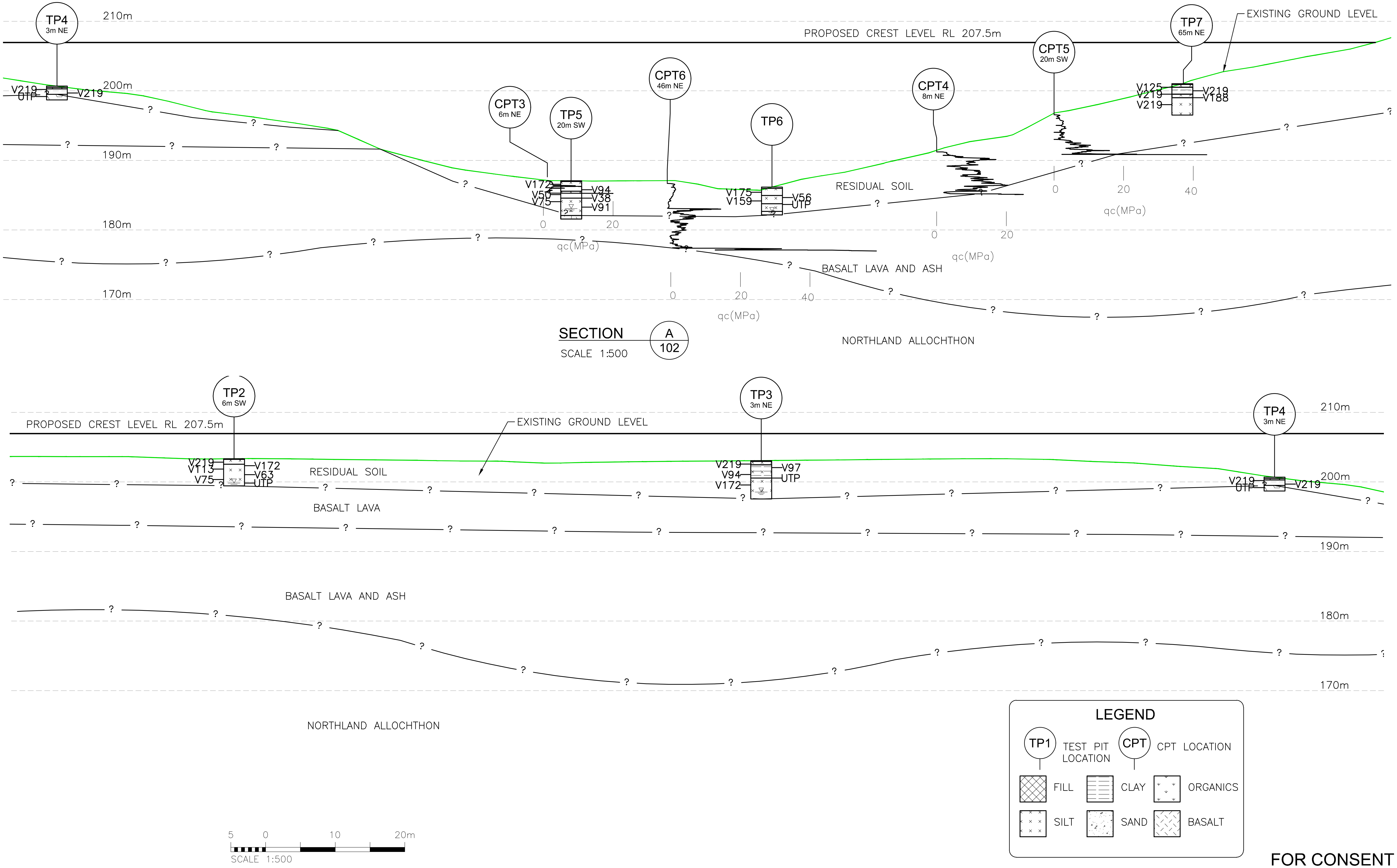
REV.: 1



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SHEET TITLE GEOTECHNICAL LONG SECTION A

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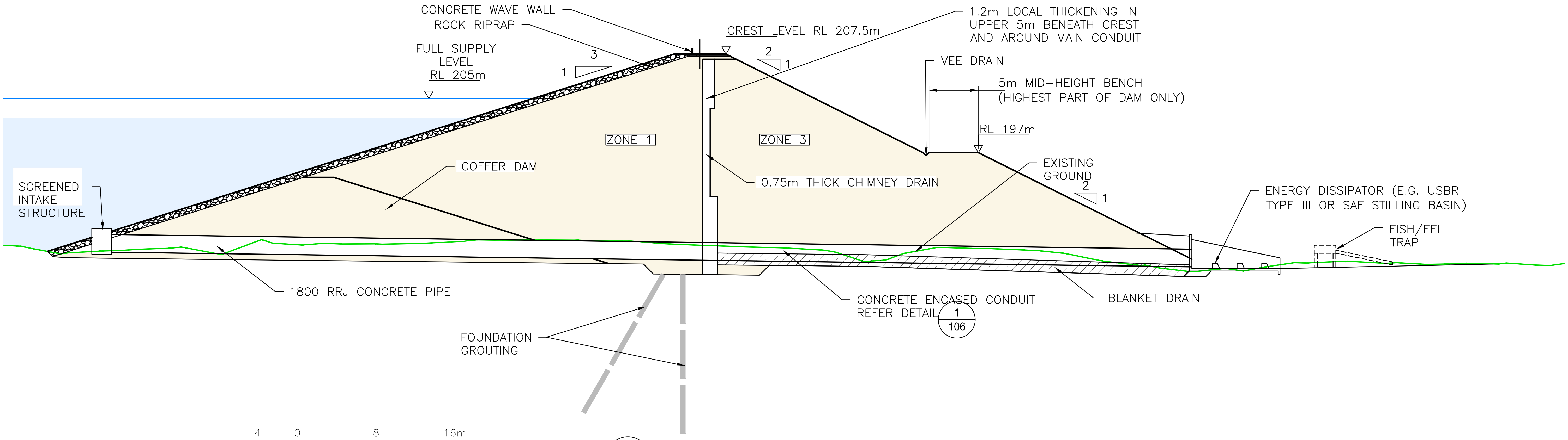

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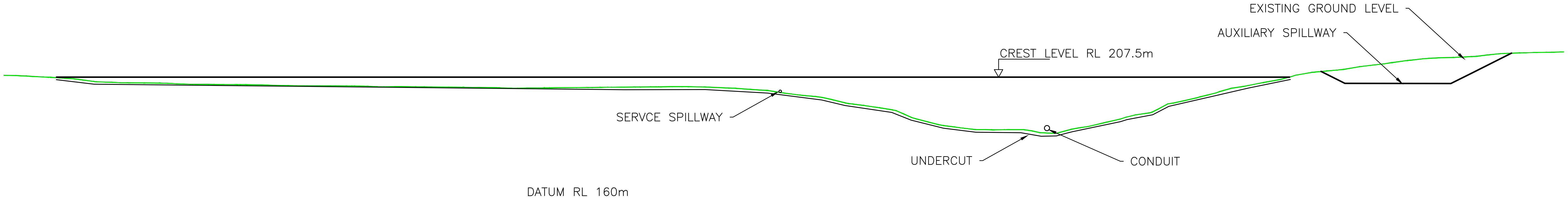
SECTION B 102 TYPICAL DAM CROSS SECTION @ MAXIMUM HEIGHT

SCALE 1:400



DAM LONG SECTION @ CENTRELINE

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SCALE 1:1500

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SHEET TITLE DAM CROSS AND LONG SECTIONS

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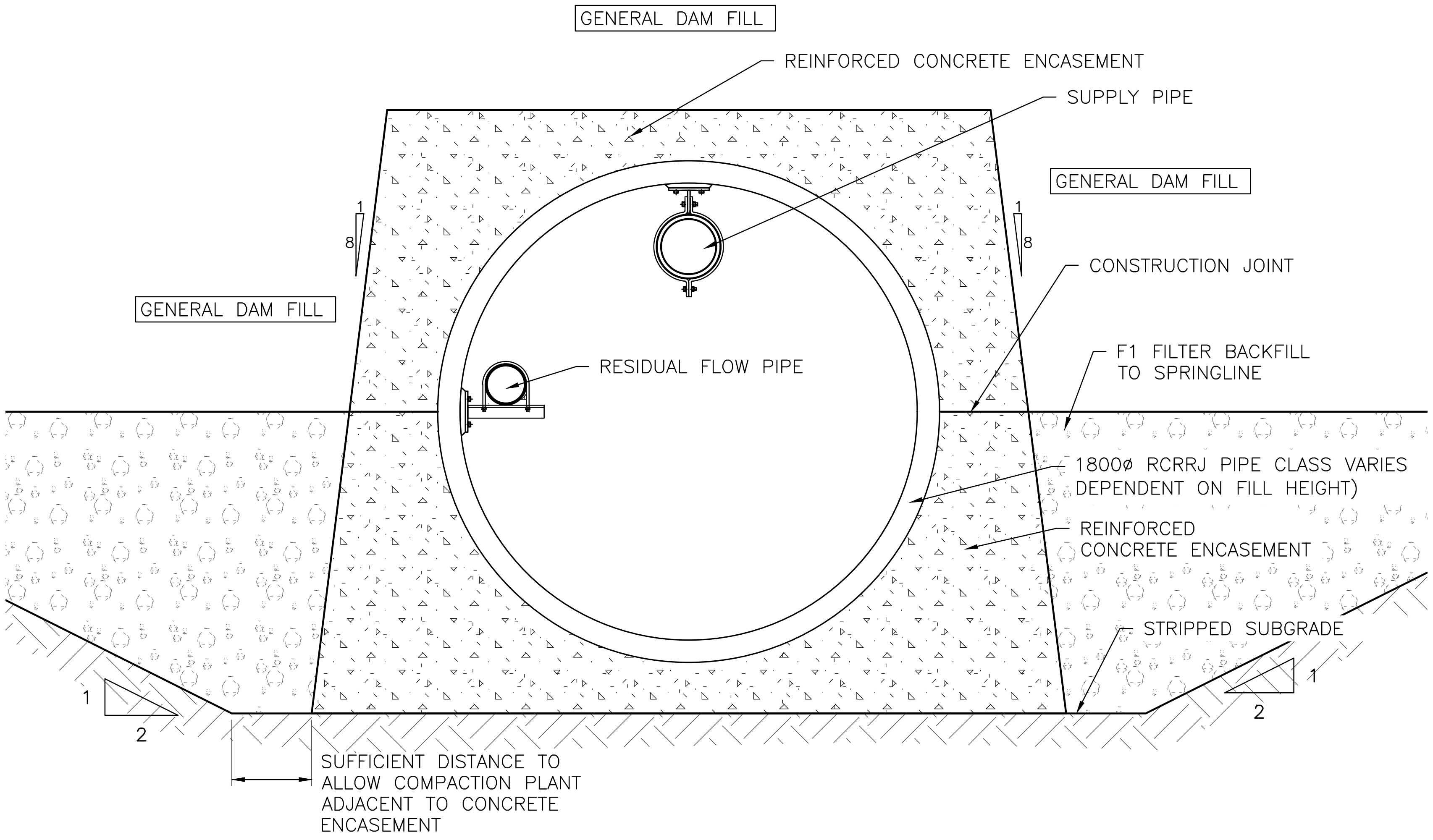

DETAIL 1/105 TYPICAL CONDUIT CROSS SECTION

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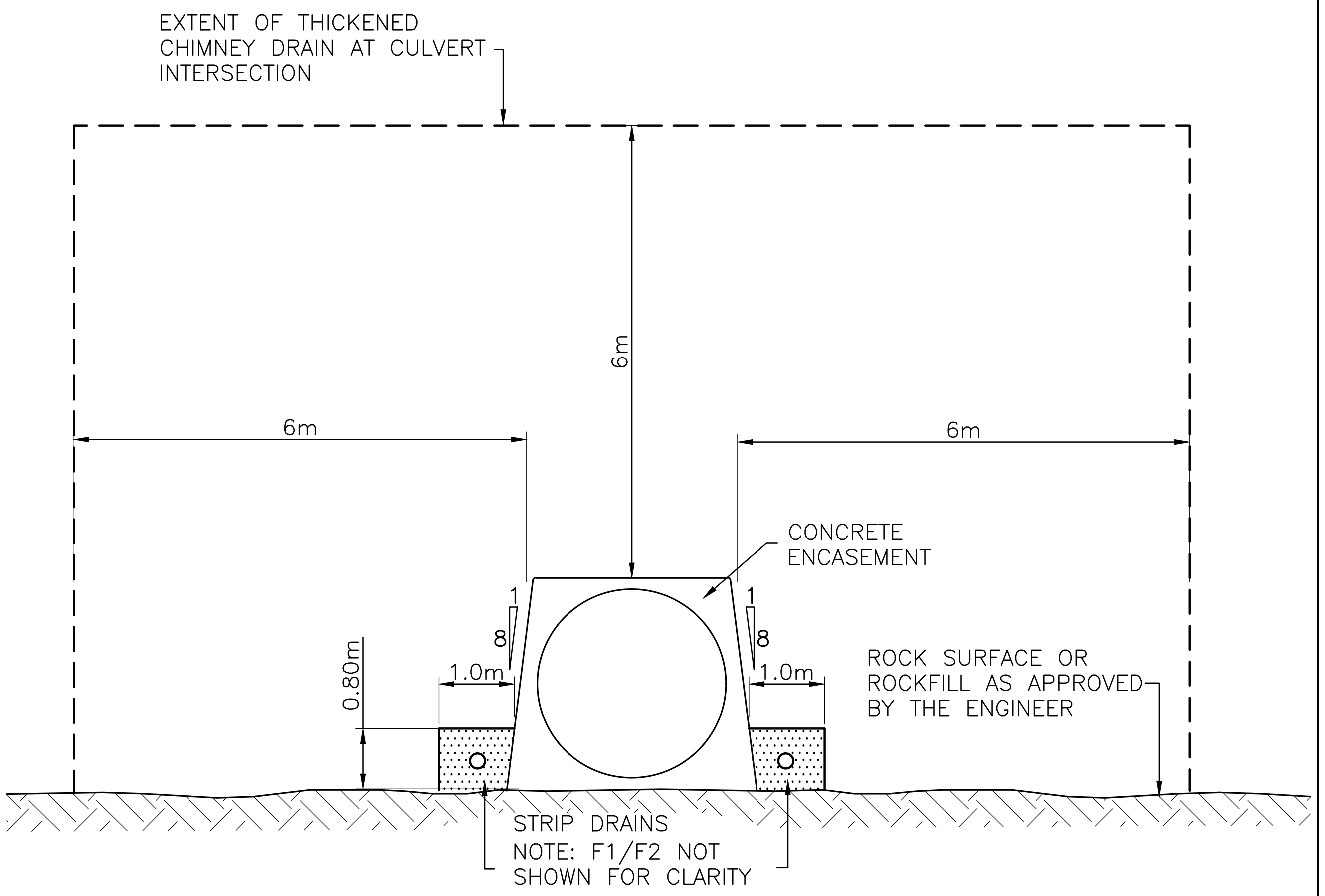
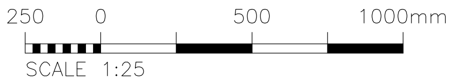


ELEVATION 1/- CHIMNEY DRAIN THICKENING AT CONDUIT

SCALE 1:100



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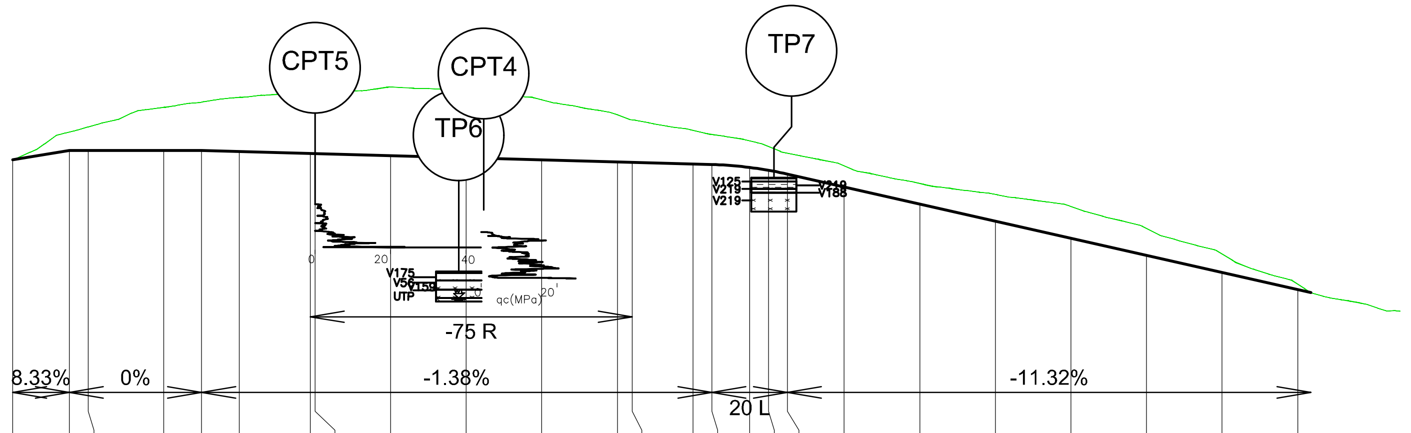
VERTICAL ALIGNMENT

DATUM 184.00



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CUT - / FILL +	-0.00	-2.43	-3.12	-5.69	-6.37	-7.14	-8.44	-8.46	-9.07	-8.39	-7.93	-6.23	-5.62	-4.45
CHAINAGE	0.00	15.00	20.00	40.00	50.00	60.00	78.76	80.00	100.00	120.00	140.00	160.00	163.93	180.00

DESIGN SURFACE LEVELS	203.14	202.75	202.37	201.87	200.17	197.91	195.64	193.38	191.12	188.85	186.59		
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CUT - / FILL +	-3.98	-3.52	-3.14	-2.77	-2.81	-2.72	-3.54	-4.20	-3.56	-2.45	-0.72		
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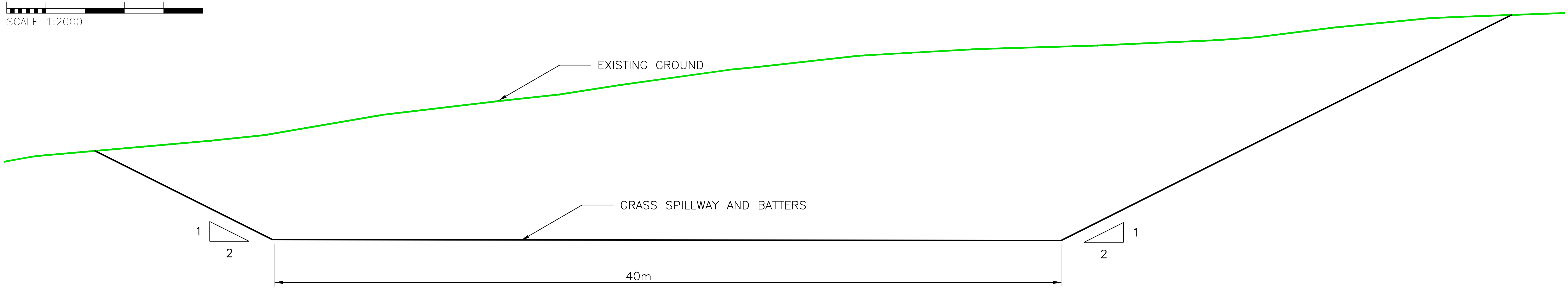
AUXILIARY SPILLWAY LONG SECTION

SCALE 1: 2000 HOR 1:1000 VERT

20 0 40 80m
SCALE 1:2000



2 0 4 8m
SCALE 1:200

AUXILIARY SPILLWAY TYPICAL CROSS SECTION

SCALE 1: 200

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CADFILE 200240_3-107.dwg
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TEMPORARY FLOOD CONTROL WORKS DURING CONSTRUCTION

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CADFILE: 200240_3–108.dwg
SCALE (A3): 1:4000
ORIG. SHEET SIZE: A3
DRAWING No.: 200240/3-108
REV.: 1

Appendix E. Hydrology and Hydraulic Assessment Report

RILEY
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HYDROLOGY AND HYDRAULIC ASSESSMENT TE RUAOTEHAUHAU WATER STORAGE RESERVOIR KAIKOHE

Engineers and Geologists

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RILEY CONSULTANTS

HYDROLOGY AND HYDRAULIC ASSESSMENT TE RUAOTEHAUHAU WATER STORAGE RESERVOIR, KAIKOHE

Report prepared for: Te Tai Tokerau Water Trust

Report prepared by: Habib Ahsan, Principal – Water Resources

……………………………..

Report reviewed by: Vaughan Martin, Principal – Water Resources

……………………………..

Report approved for issue by: Don Tate, Director, CPEng

……………………………..

Report reference: 200240-F

Date: 1 September 2020

Copies to: Te Tai Tokerau Water Trust 1 electronic copy

Riley Consultants Ltd 1 copy

Issue:	Details:	Date:
1.0	Hydrology and Hydraulic Assessment	1 September 2020

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Appendices

Appendix A: HEC-RAS Summary
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RILEY Dwg: 200240/3-222 PMF Peak Velocities

HYDROLOGY AND HYDRAULIC ASSESSMENT TE RUAOTEHAUHAU WATER STORAGE RESERVOIR, KAIKOHE

1.0 Introduction

This preliminary hydrology and hydraulic assessment has been prepared by Riley Consultants Ltd (RILEY), at the request of Te Tai Tokerau Water Trust. This report details the assessment and is intended to support a resource consent application for the construction a large dam.

The scope of the assessment was as follows:

- Estimation of inflow hydrographs for a range of design events in general accordance with the New Zealand Dam Safety Guidelines (New Zealand Society on Large Dams (NZSOLD), 2015) (NZSOLD Guidelines).
- A sunny day potential impact classification (PIC) assessment in general accordance with the NZSOLD Guidelines.
- Preliminary design of the spillway arrangement to provide adequate protection to the dam during the design flood event.
- Preliminary design of the temporary flood diversion works during construction.

2.0 Background

The proposed Te Ruaotehauhau water storage reservoir is located on the Pekapeka Stream immediately downstream of the confluence of the Waitaia Stream and the Te Ruaotehauhau Stream. The Pekapeka Stream passes to the west of Ohaeawai. Rivers further downstream include the Waiaruhe River and the Waitangi River, which discharges to the estuary at Haruru. The dam location, relative to other identifying features, is presented on RILEY Dwg: 200249/3-200. The site was previously referred to as MN06.

Photo 1: Looking upstream from the right abutment. The confluence of the Waitaia Stream and the Te Ruaotehauhau Stream is visible to the left side of the photo.

Photo 2: Looking upstream from a culvert crossing approximately 500m downstream of the proposed dam site

3.0 Downstream Effects and Potential Impact Classification

A PIC assessment considers the consequences of an uncontrolled release of the reservoirs' contents as a result of a dam breach. PIC assessments are independent of the likelihood of a failure, which, for a suitably designed, constructed, and operated dam, should be very low.

A comprehensive PIC assessment involves determining dam breach characteristics, and hydraulic modelling downstream of the dam.

Module 2 of the NZSOLD Dam Safety Guidelines (2015) outlines the consequence assessment and dam classification framework adopted in New Zealand. It considers three principal components, being:

1. Damage level.
2. Population at risk.
3. Potential loss of life.

Dams are categorised as low, medium, or high PIC based on these components.

The NZSOLD Guidelines provide design criteria, construction, and operation requirements for each PIC, with a high PIC dam having the highest criteria. Such a classification system ensures the dam performance requirements are appropriate for the hazard posed by the reservoir.

4.0 Dam Breach Hydraulic Assessment

4.1 Hydraulic Methodology

We have used HEC-RAS (v5.07) to simulate a breach of the dam. The full momentum equation set has been used.

4.2 Terrain

A 5m Digital Elevation Model (DEM) was sourced from Northland Regional Council (NRC). We understand that the DEM was created from a Light Detection and Ranging (LiDAR) survey undertaken in 2017. The DEM covers the full catchment area to the proposed dam and extends downstream to the Waiaruhe River and the Waitangi River confluence. The vertical datum and horizontal projections used are NZVD 2016 and NZTM 2000, respectively. We have used the same vertical datum and horizontal projections within this assessment. We understand that site specific survey information is not available at this time. RILEY did not make any modifications to the terrain.

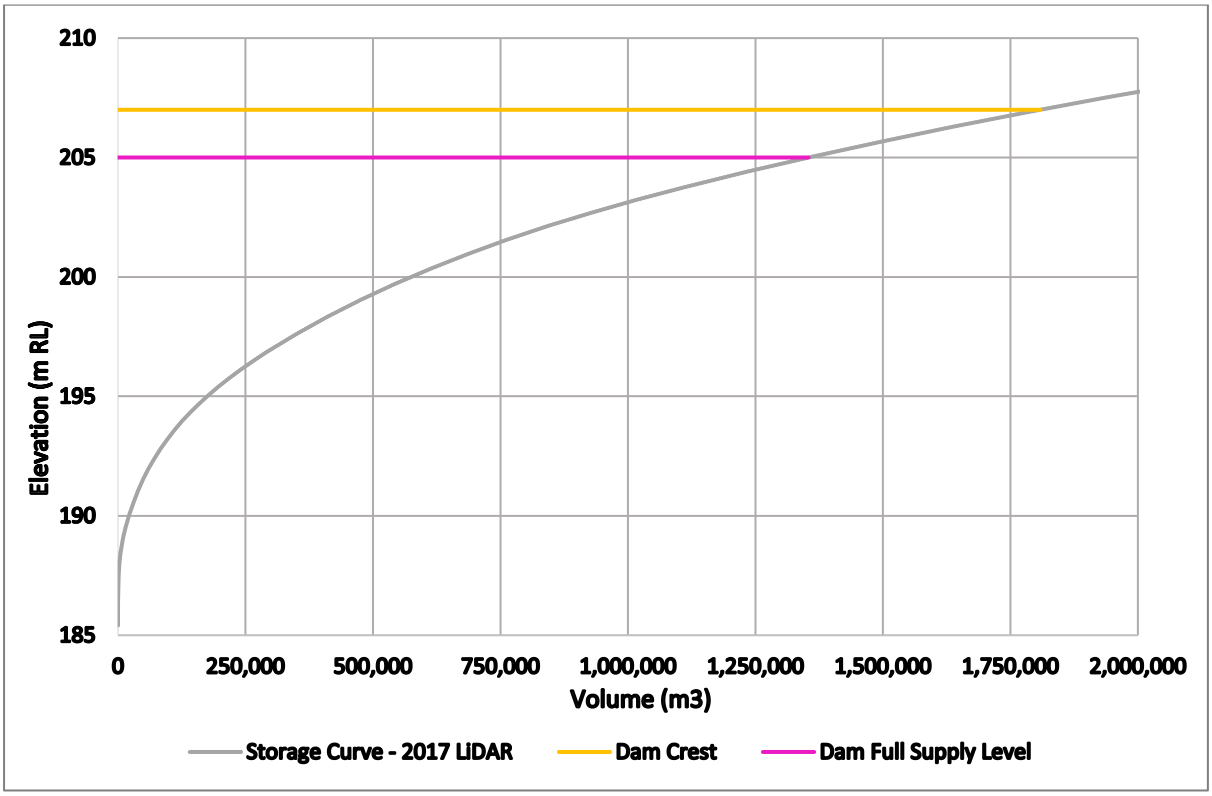
4.3 Breach Scenarios

For the purposes of this preliminary design we have assessed a sunny day piping scenario. A rainy-day scenario will also need to be considered during detailed design.

4.4 Geometry

The reservoir has been modelled as a storage area. The elevation-storage relationship (derived from the storage area extent within the HEC-RAS model) is presented within Figure 1. The storage volume at the full supply level is approximately 1.35million m^3.

Figure 1: Elevation Storage Relationship



The area downstream of the dam has been modelled as a 2D flow area, with a 5m by 5m grid, and a global Manning's 'n' value of 0.06. The 2D flow area extends to downstream of the State Highway 1 (SH1) crossing over the Waiaruhe River.

The dam has been modelled as a connection between the reservoir storage area and the downstream 2D flow area. The dam has a proposed full supply level of RL 205m with an interim crest elevation of RL 207m. The downstream dam toe will have an elevation of approximately RL 185.3m.

4.5 Breach Parameters

The main parameters used to derive the breach parameters are presented within Table 1.

Table 1: Input Parameters for Breach Parameter Estimation

Parameter	Value	Source
Dam Toe Elevation (m RL)	185.3	LiDAR
Service Spillway Crest (m RL)	205	Design Value
Dam Crest (m RL)	207	Interim Design Value
Retained Volume Service Spillway Crest (m^3)	1,354,000	LiDAR (conservative)
Final Breach Invert Level (m RL)	185.3	Slightly above downstream terrain
Height of water above breach invert (m)	19.70	Breach invert subtracted from spillway crest
Average embankment width (m)	220	LiDAR
Approach flow width (m)	220	LiDAR

Figure 2: Breach Profile

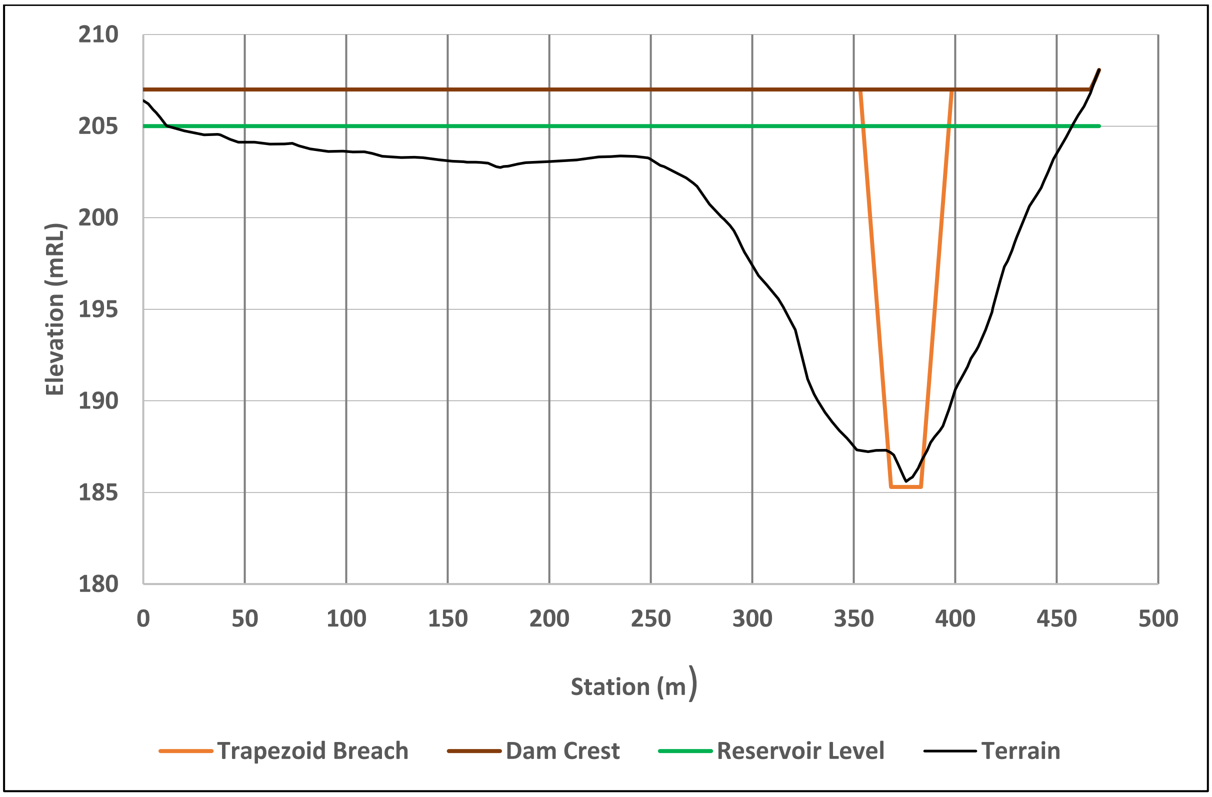


Table 2 presents the dam breach parameters calculated using the methods outlined in Wahl 1998. Froehlich (1995) is the most recent method for estimating dam breach parameters (within Wahl 1998) and it uses the largest number of case studies in the development of its empirical equations. The Froehlich (2016) method has been developed in the time since the NZSOLD Guidelines were published.

We, therefore, gave greater weighting to the Froehlich 2016 method. Full details are provided within the appended calculations.

Table 2: Dam Breach Parameters

Method	Average Breach Width, B (m) [1]	Formation Time, t_f (minutes)	Z (H:V)
Johnson and Illes (1976)	10.9 – 65.1	n/a	n/a
Singh and Snorrason (1982, 1984)	43.4 – 108.5	15 – 60[2]	n/a
MacDonald and Langridge-Monopolis (1984)	n/a	34.2	n/a
FERC (1987)	43.7 – 86.8	6 – 60[2]	0.25 – 1[2]
USBR (1988)	59.1	39	n/a
Froehlich (1995) - Piping	45.5	19.8	1.4
Froehlich (2016) - Piping	29.1	18.6	0.7

Notes:

1 Range shown if applicable

2 Range provided by method without any calculation

The larger the dam breach width (B) and shorter the formation time (t_f), the larger the peak outflow will be. The side slope of the breach shape is of secondary importance.

HEC-RAS uses a bottom breach width, not the average breach width (as derived using the Froehlich methods). We have used a bottom breach width of 14.7m for the piping breach scenario (with an average breach width of 30m and side slopes of 0.7). A cross section of the breach profile is presented in Figure 2.

Table 3: Breach Parameters

Parameter	RILEY
Breach Bottom Width (m)	14.7
Breach Bottom Elevation (m RL)	185.3
Left Side Slope (H):(V)	0.7:1
Right Side Slope (H):(V)	0.7:1
Formation Time (minutes)	18

4.6 Downstream Boundary Condition

A normal depth boundary condition (friction slope = 0.00507) has been used at the downstream boundary, located approximately 500m downstream from the SH1 bridge at the Waiaruhe River. We consider that the assumed downstream boundary condition is unlikely to affect the model results at the location of interest.

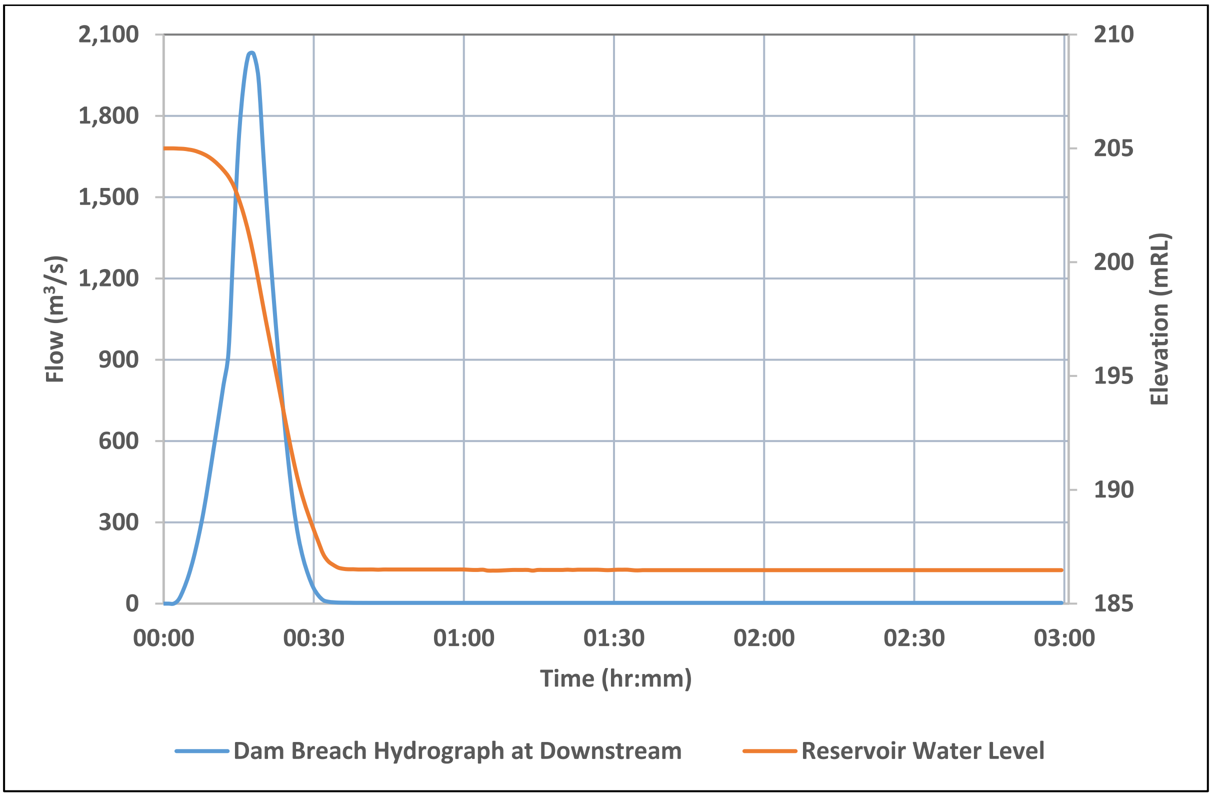
4.7 Initial Condition

We have used an initial condition of RL 205m for the reservoir storage area.

4.8 Results

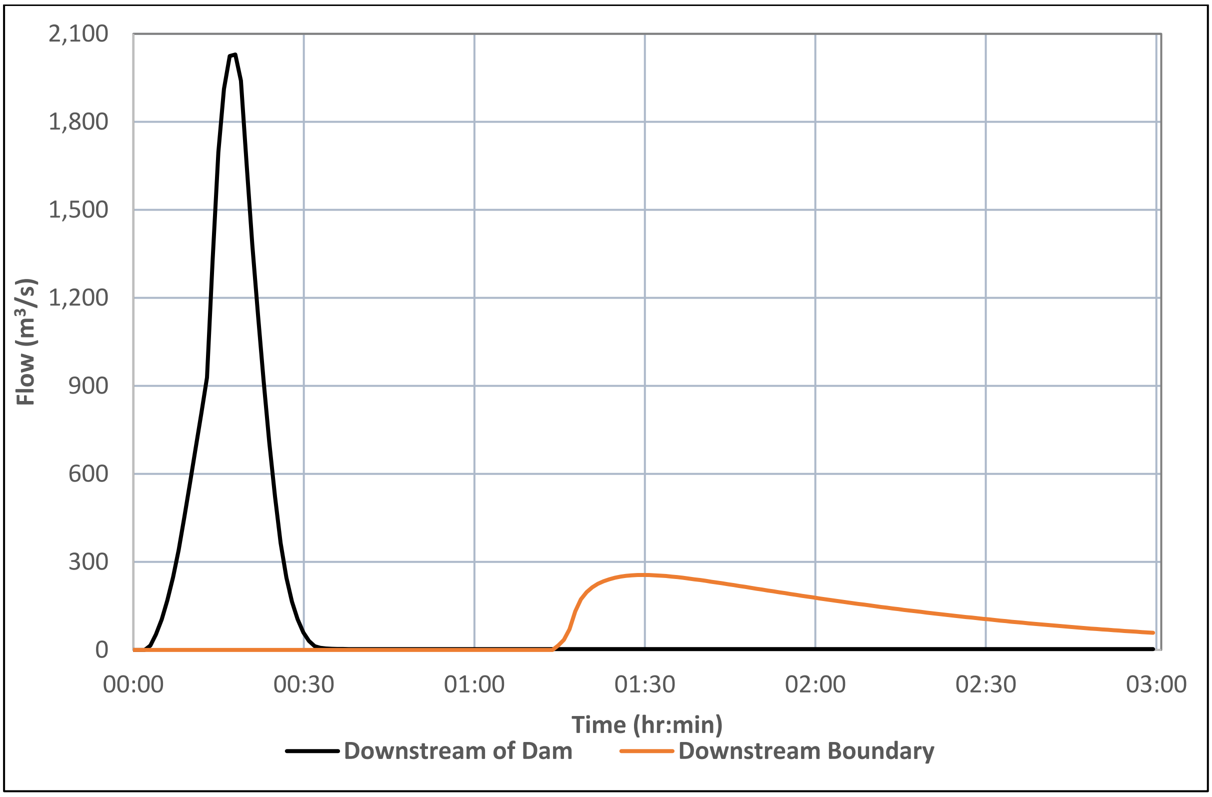
Figure 3 presents the reservoir level and outflow hydrograph immediately downstream of the dam.

Figure 3: Dam Breach Hydrograph and Reservoir Water Level



The resultant breach hydrograph at the dam site along with the flow hydrograph at downstream boundary is presented within Figure 4. The figure demonstrates that the peak discharge from the dam is approximately 2,030m^3/s. The peak flow at the downstream boundary is 255m^3/s indicating significant attenuation of breach flow. We note that dam breach overtops SH1, to the north of the intersection with State Highway 12 (SH12). Once overtopping occurs at this point, the flow enters a neighbouring catchment (Titahi Stream).

Figure 4: Dam Breach and Downstream Boundary Hydrographs



For comparison, the predicted peak breach outflows by the Froehlich methods are presented in Table 4. Overall, there is a significant range in results. The predicted flow from HEC-RAS is about 28% higher than the Froehlich (1995) estimate and is approximately twice the flow derived by formulations of Froehlich (2016).

Table 4: Comparison of Peak Breach Outflows

Method	Peak Outflow (m^3/s)
Froehlich (1995)	1,575
Froehlich (2016) – Empirical	869
Froehlich (2016) – Semi-theoretical	960
HEC-RAS Model	2,030

Froehlich 2016 also presents 42 dams that have breached, which have measured peak outflows. The four dams that are most similar in reservoir volume and breach height to the proposed dam are presented in Table 5. Based on this comparison, it would appear likely that the potential peak flow at Te Ruaotehauhau Water Storage Reservoir would be greater than 1,050m^3/s and less than 2,370m^3/s.

Table 5: Breach Flow Comparison

Dam Name and Location	Volume (million m^3)	Height of Water Above Breach (m)	Peak Outflow (m^3/s)
Te Ruaotehauhau Water Storage Reservoir	**1.35**	**19.7**	**2,030**
Bradfield (Dale Dyke), England	3.2	28.0	2,370
Lake Avalon, New Mexico	31.5	13.7	2,320
Little Dear Creak, Utah	1.36	22.9	1,330
Laurel Run, Pennsylvania	0.555	14.1	1,050

Overall, the HEC-RAS predicted peak flow of 2,030m^3/s appears conservative (perhaps at the upper bound), and we consider the derived hydrograph is appropriate to be used for the PIC assessment. We note that a hydraulic sensitivity analysis has not been undertaken.

4.9 Drawings

The drawings within Appendix A and summarised in Table 6, present the model results.

Table 6: Drawing Summary

Drawing Number	Drawing Name
200240/3-200	Downstream Floodplain Overview
200240/3-201 to -202	Sunny Day Breach - Peak Levels (Areas 1 and 2)
200240/3-203 to -204	Sunny Day Breach - Peak Depth (Areas 1 and 2)
200240/3-205 to -206	Sunny Day Breach - Peak Depth Velocity Product (Areas 1 and 2)

5.0 Damage Level Assessment

5.1 General

The damage level assessment requires the assessment of individual specified categories, as outlined in the following sections. The damage level is taken as the highest damage level from each of the categories. The damage levels from lowest to highest damage are minimal, moderate, major, and catastrophic.

5.2 Residential Houses

The NZSOLD Guidelines define destroyed as rendered uninhabitable but does not define uninhabitable. We note that the NZSOLD Guidelines make references to the following publications with regards to damage to residential houses:

- RESCDAM (2010) – includes test data on the performance of buildings in flowing water as a function of building type, flood depth, and velocity.
- National Institute of Weather and Atmosphere (NIWA, 2010) – provides potential damage curves as a function of building type and flood depth, based on observed data from floods and tsunamis in New Zealand.

NIWA (2010) provides a graph (Figure 5), that presents curves for the damage threshold and the total destruction threshold of timber/weatherboard buildings, based on the depth and velocity of flood waters. The figure indicates that at flood depths less than 3m, velocity damage occurs when the product of depth and velocity (D x V) is 1.5m^2/s and total destruction occurs when D x V is greater than 3m^2/s, as shown in Table 7.

Figure 5: Inundation Depth and Velocity Thresholds for: (a) Onset of Damage due to Water Velocity; and (b) Total Destruction, of Timber/Weatherboard Buildings (NIWA, 2010).

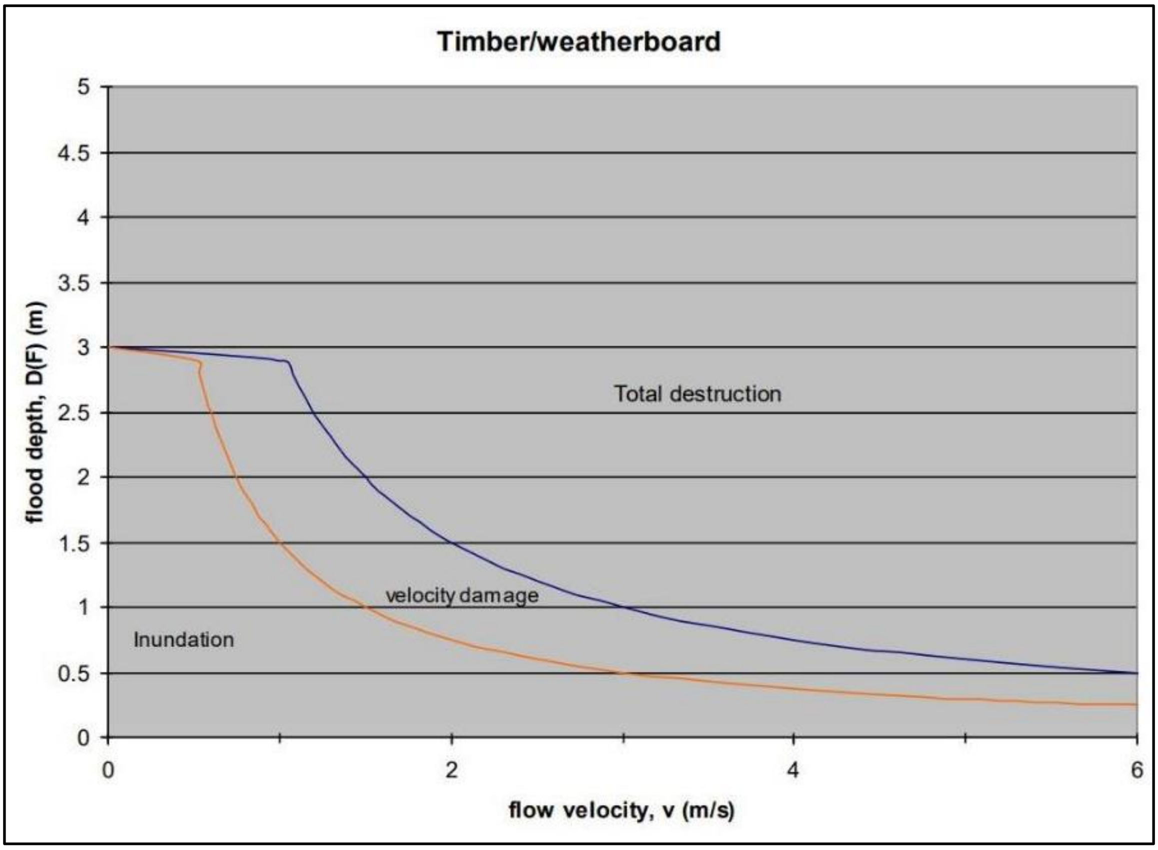


Table 7: Depths and Velocity Points from Curves Presented in Figure 5

Scenario	Depth (m)	Velocity (m/s)	D x V
Velocity Damage Threshold (orange line)	1.5	1.0	1.5
	1.0	1.5	1.5
	0.5	3.0	1.5
Total Destruction Threshold (blue line)	2.0	1.5	3.0
	1.5	2.0	3.0
	1.0	3.0	3.0

An alternative conservative approach is to consider the number of houses that are surrounded by greater than 0.5m of water (above surrounding ground levels). Such inundation could render a house uninhabitable (and therefore destroyed) due to static water damage.

We have used the latest building outline information from Land Information New Zealand (LINZ) to assess the number of residential houses affected. We have made our best judgment on whether buildings are residential in nature (i.e. habitable). Some are difficult to assess from aerial imagery and therefore we have provided a range of affected houses.

Affected houses are highlighted on the drawings. The residential houses affected are all located within Ohaeawai. There are 47 residential houses within Ohaeawai village have been identified to be affected by depths greater than 0.5m. We note that there are no houses located below the SH12 road embankment crest level.

No affected residential houses have been identified downstream of Ohaeawai through to the SH1 bridge.

Table 8 presents a summary of the residential house assessment. Based on this, we consider that nine houses are likely to be destroyed, with up to nine other houses damaged by velocities to some extent. We consider that a major damage level is appropriate for the residential houses, as highlighted within Table 9.

Table 8: Residential House Summary

Scenario	Depth > 0.5m	1.5 m^2/s <D x V<3.0 m^2/s	D x V >3.0m^2/s
Sunny Day Piping	36 - 47	6 - 9	7 - 9

Table 9: Residential Houses Damage Level

Damage Level	Residential Houses
Catastrophic	More than 50 houses destroyed.
Major	Four to 49 houses destroyed, and a number of houses damaged.
Moderate	One to three houses destroyed and some damaged.
Minimal	Minor damage.

5.3 Critical or Major Infrastructure

The NZSOLD Guidelines state that critical or major infrastructure includes:

a. Lifelines (power supply, water supply, gas supply, transportations systems, wastewater treatment, telecommunications (network mains and nodes rather than local connections)); and

b. Emergency facilities - (hospitals, police, fire services); and

c. Large industrial, commercial, or community facilities, the loss of which would have a significant impact on the community; and

d. The dam, if the service the dam provides is critical to the community and that service cannot be provided by alternative means.

Table 10 presents the critical or major infrastructure we have identified downstream of the dam, via a review of aerial photography. We do not consider that the proposed dam meets the definition of critical or major infrastructure.

Table 10: Critical or Major Infrastructure Identified Downstream of Dam

Infrastructure	Comment
State Highway 12 Culvert/Road Embankment	Likely to be damaged due to significant overtopping of road.
State Highway 1 Bridge (Waiaruhe River)	Some erosion damage likely at the abutments with a peak flow of approximately 250m3/s, although the bridge deck and beams appear likely to remain above the peak water level.

Based on the assessment above, we consider that a moderate damage level is appropriate for critical or major infrastructure, as highlighted within Table 11.

Table 11: Critical or Major Infrastructure Damage Level

Damage Level	Critical or Major Infrastructure
Catastrophic	Extensive and widespread destruction and damage to several major infrastructure components.
Major	Extensive destruction and damage to more than one major infrastructure component.
Moderate	Significant damage to at least one major infrastructure component.
Minimal	Minor damage to major infrastructure components.

5.4 Time to Restore Operation to Critical or Major Infrastructure

We consider any damage to critical or major infrastructure is likely to take up to three months to restore operation. Therefore, a moderate damage level is appropriate to restore operation to critical or major infrastructure, as highlighted within Table 12.

Table 12: Time to Restore Operation to Critical or Major Infrastructure

Damage Level	Critical or Major Infrastructure
Catastrophic	More than one year
Major	Up to 12 months
Moderate	Up to three months
Minimal	Up to one week

5.5 Natural Environment

The effects of a dam breach on the natural environment downstream may include deposition of sediment and scour within the downstream watercourses, potentially impacting water quality and fish habitat.

We consider that the damage to the natural environment downstream of the dam is likely to be significant but recoverable. Therefore, we considered that a moderate damage level is appropriate for the natural environment, as highlighted within Table 13.

Table 13: Natural Environment Damage Level

Damage Level	Natural Environment
Catastrophic	Extensive and widespread damage.
Major	Heavy damage and costly restoration.
Moderate	Significant but recoverable damage.
Minimal	Short-term damage.

5.6 Community Recovery Time

We consider the community would take months to recover from a dam breach. Therefore, we consider that a Moderate damage level is appropriate for the community recovery time, as highlighted within Table 14.

Table 14: Community Recovery Time Damage Level

Damage Level	Community Recovery Time
Catastrophic	Many years
Major	Years
Moderate	Months
Minimal	Days to weeks

5.7 Damage Level Summary

Table 15 summarises the selected damage levels for each of the categories. The highest damage level from the five categories is major and therefore, the damage level for the dam is major.

Table 15: Damage Level Summary

Category	Damage Level
Residential Houses	Major
Critical or Major Infrastructure	Moderate
Time to Restore Operation to Critical or Major Infrastructure	Moderate
Natural Environment	Moderate
Community Recovery Time	Moderate

6.0 Population at Risk

6.1 General

The Population at Risk (PAR) is defined as the number of people likely to be incrementally affected by inundation greater than 0.5m if a dam breach occurs. When evaluating PAR, the potential evacuation of people is not considered. The NZSOLD Guidelines require the PAR to be determined as one of the following:

- 0
- 1 to 10
- 11 to 100
- Greater than 100

The PAR will vary with time of day, week, and year. The NZSOLD Guidelines state that the most critical situation should be used to determine the PAR. The PAR does not take into account exposure times, except for temporary populations on designated routes. We have not undertaken a site inspection as part of the PAR estimate.

The following sections provide an outline of the assessed PAR.

In general, the model results indicate that the areas to the west of SH1 within Ohaeawai Village will experience flooding greater than 0.5m depth. The area to the east and south will experience flooding but generally less than 0.5m depth. There are some notable features in this area such as:

- Ohaeawai School
- Ohaeawai Community Pre-School

- Ohaeawai Hotel
- A freedom camping location (Carpark Te Corner)

These features are not included in the PAR assessment, as the predicted flood depth does not exceed 0.5m.

6.2 Residential Houses

As presented within the residential house damage level assessment, a number of residential houses appear to be located in areas where inundation depths are predicted to exceed 0.5m (above surrounding ground levels). These houses are highlighted within the drawings. The total number of houses meeting the 0.5m threshold is predicted to be 36 to 47 (noting again that aerial imagery has been used to identify residential houses from other buildings such as sheds etc.). We note that a specific floor level survey has not been undertaken. If such a survey was undertaken, the number of houses meeting the threshold may reduce.

As per the latest census in 2018, the population of 1,140 in Ohaeawai was located within 408 occupied houses, which is approximately 2.8 people/house. Assuming an occupancy rate of 2.8 people/house, the PAR associated with the residential dwellings is 100 to 130.

We note that we have not made a specific increased allowance for a bed and breakfast (Quiet Waters) located with the 0.5m deep floodplain.

6.3 Community Facilities

We have not identified any facility that will be affected by at least 0.5m depth of water and therefore the PAR will be zero.

6.4 Business Areas

The majority of the small businesses within the village appear to be located outside the 0.5m deep floodplain. The LINZ building classification indicates that one commercial building (at 41 SH1) will be affected by flood waters greater than 0.5 depth. The large building appears to be associated with an orchard or similar. The PAR associated with commercial premises is difficult to estimate, without undertaking a site inspection. As a conservative estimate we have allowed for a workforce of 10 to 20 people at the building, and within the property as a whole.

6.5 Recreational Areas

The Ohaeawai Rugby Club fields are predicted to be inundated by depths greater than 0.5m, although the flood depth at the clubrooms appears to be less than 0.5m. If the breach occurred at the time of a rugby game, the PAR could be in the order of 30 to 50.

We have not identified any other specific public areas that will be exposed to flood depths greater than 0.5m.

6.6 Road Crossings

The dam breach floodplain exceeds 0.5m depth across both SH12 and Remuera Settlement Road.

Considering exposure times, the PAR associated with road crossings is likely to be low. We consider the PAR associated with road crossings is likely to be less than 5.

6.7 Discussion

The PAR may vary considerably depending on the time of day and day of week of a breach. We consider Table 16 provides an appropriate summary of the PAR, noting that the PAR associated with business and recreational areas will be significantly lower at times (i.e. at night for both business and recreational areas and during week days for recreational areas). The PAR is in the highest category, for the PIC assessment (greater than 100), therefore, we do not consider it critical to further refine the PAR estimates.

Table 16: Population at Risk Summary

Type	Population at Risk
Residential Houses	100 - 130
Community Facilities	0
Business Areas	10 - 20
Recreational Areas	30 - 50
Road Crossings	0 - 5
TOTAL	140 - 205

7.0 Potential Loss of Life

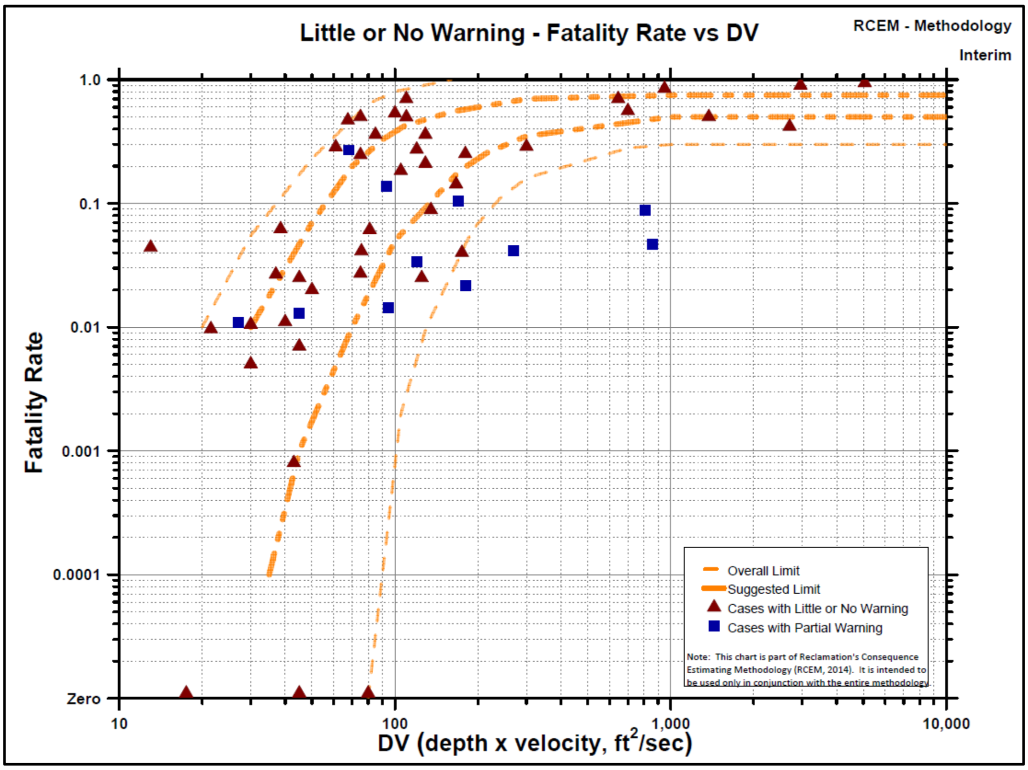
The NZSOLD Guidelines require that a high PIC is used if two or more lives are highly likely to be lost or a medium PIC if a life is highly likely to be lost. The NZSOLD Guidelines do not provide a definition of highly likely or guidance on the weighting of the different potential dam breach scenarios (unlike the PAR where the guidelines clearly state that the most critical situation should be used). The potential loss of life (PLL) takes evacuation into account.

In 2014, the United States Bureau of Reclamation developed a methodology for estimating PLL entitled Reclamation's Consequences Estimation Methodology (RCEM). RCEM provides a graphical approach giving the fatality rate as a function of the D x V and amount of warning time (based on measured fatality rates in actual dam breach events).

Model results indicate that the first residential houses downstream of the dam could be inundated by greater than 0.5m of water within 20-minutes of an instantaneous breach initiation such as a seismic event. We therefore consider that there is a possibility that the opportunity for evacuation is limited.

Figure 6 presents a figure from RCEM for little to no warning. The figure uses the empirical units of ft^2/s. The important feature of the figure, in this case, is that a D x V product of $30ft^2/s$ (or approximately $3m^2/s$) has a fatality rate of approximately 0.01 (at the upper end of the suggested limit). The flood drawings present the DxV results. The typical DxV in the vicinity of the PAR is approximately $3m^2/s$. Using a fatality rate of 0.01 and assuming PAR of 140, the statistical PLL is 1.4.

Figure 6: RCEM 2014 Fatality Rate – Little to No Warning



We consider that a detailed assessment of the residential houses and PAR would be required to further refine the PLL assessment. However, there is sufficient evidence to conclude that it is highly likely that at least one life will be lost.

8.0 Potential Impact Classification

The PIC assessment is summarised within Table 17 (as taken from the NZSOLD Guidelines). Given that the damage level is major, the PAR more than 100, the table indicates that the dam should have a high PIC.

We note that as four or more houses are highly likely to be destroyed, the assessed dam classification is not sensitive to the other damage categories or the PAR.

Table 17: Determination of Dam Classification

Assessed Damage Level	**Population at Risk (PAR)**			
	0	**1 to 10**	**11 to 100**	**More than 100**
Catastrophic	High	High	High	High
Major	Medium	Medium/High^{4}	High	High
Moderate	Low	Low/Medium/High^{3,4}	Medium/High^{4}	Medium/High^{2,4}
Minimal	Low	Low/Medium/High^{1,3,4}	Low/Medium/High^{1,3,4}	Low/Medium/High^{2,3,4}

Notes:

1 With a PAR of five or more people, it is unlikely that the potential impact will be low.
2 With a PAR of more than 100 people, it is unlikely that the potential impact will be medium.
3 Use a medium classification if it is highly likely that a life will be lost.
4 Use a high classification if it is highly likely that two or more lives will be lost.

9.0 Flood Design Criteria

The PIC assessment classifies the dam as High PIC. The NZSOLD Guidelines recommend that a high PIC dam has an Inflow Design Flood (IDF) between the 10,000-year flood event and the Probable Maximum Flood (PMF), as outlined in Table 18.

Table 18: Recommended Minimum Inflow Design Floods (NZSOLD, 2015)

PIC	PAR	PLL	IDF
Low	0 to 10	0	100 to 1,000
Medium	0 to 10	0	1,000
	0 to 10	1	2,500
	11 to 100	0 to 1	10,000
High	No limits	0 to 1	10,000
	No limits	>10	PMF

In this instance, we consider that the most appropriate design event is the PMF.

10.0 Hydrology

10.1 Methodology

NZSOLD (2015) recommends that two or more methods are used to determine the inflow design flood. For this assessment we have:

1. Developed a rainfall-runoff model using HEC-HMS.
2. Undertaken a regional based flood frequency assessment.

We have not undertaken a flood frequency analysis on nearby flow gauges, noting that both the NIWA portal and NRC website show there are three flow gauges on Waitangi River. These are Waitangi at Waimate North Road (since 2016), Waitangi at SH10 (since 2012) and Waitangi at Wakelins (since 2001).

We note that there are large uncertainties in estimating flood events in excess of the 100-year event. We have therefore used a conservative approach as suggested by NZSOLD (2015) in determining the appropriate inflow design flood. We also note that the hydrological hazards (as well as the understanding of) can change with time, and therefore a conservative approach may also reduce the need for future upgrade works to the spillway facilities. We have not specifically allowed for climate change as recommended by NZSOLD (2015).

The NZSOLD Guidelines recommend that the PMF should be determined using Tomlinson and Thompson (1991) (and Campbell et al (1994)). However, this document was superseded by an article in the Journal of Hydrology (Volume 31 No. 2), also by Thompson and Tomlinson in 1993, for rainfall durations from 0.5-hours to 6-hours in length. The 1993 method has been used to determine total rainfall depths for a range of rainfall durations.

We have elected to undertake an assessment of the following design events:

- Mean annual flood event.
- 100-year flood event.
- 1,000-year flood event.

- 10,000-year flood event.
- Probable Maximum Flood (PMF).

10.2 Catchment Area

The catchment area was determined using the 5m DEM previously discussed. RILEY Dwgs: 200240/3-210 and -211 present the derived catchment boundary with a catchment area of 3.1km^2. We note that the NIWA GIS Portal indicates that the catchment area is between 3.42km^2 and 3.66km^2.

10.3 Infiltration

A number of methods are available to allow for soil infiltration (i.e. precipitation loss) during rainfall events. Soil infiltration is typically categorised/influenced by soil types and ground cover.

We note that NRC does not appear to have a preferred method for soil infiltration allowance. The Soil Conservation Service (SCS) method is commonly used, however, and is specified by Auckland Council within TP108. The SCS method categorises soil types into four groups (Group A, B, C or D) based on soil types. We anticipate that the soils within the catchment mainly consist of Group C soils as presented in RILEY Dwg: 200240-211. Group C soils are described as:

> *Soils that have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. These soils have a low rate of water transmission (1 to 4 mm/hr).*

The majority of the catchment is covered in pasture. Group C soils with pasture cover in good condition have a CN of 74, in accordance with SCS Technical Report 55 (1986).

The SCS method also requires the selection of the Initial Abstraction (Ia). Ia represents the initial precipitation loss at the start of a rainfall event. We note that TP108 recommends the use of Ia = 5mm in the Auckland Region.

For the purposes of this assessment we have used the SCS method, with a Curve Number (CN) of 74 for previous surfaces. We note that the Priority Rivers Modelling Report (URS, 2011) used a CN of 74 for the Waitangi River Catchment. We have used Ia = 5mm.

The proposed reservoir covers approximately 6.7% (0.21km^2) of the total catchment area. We have therefore adjusted the CN to 76 to obtain a weighted value for the entire catchment. We have not allowed for other impervious areas within the catchment.

10.4 Transform

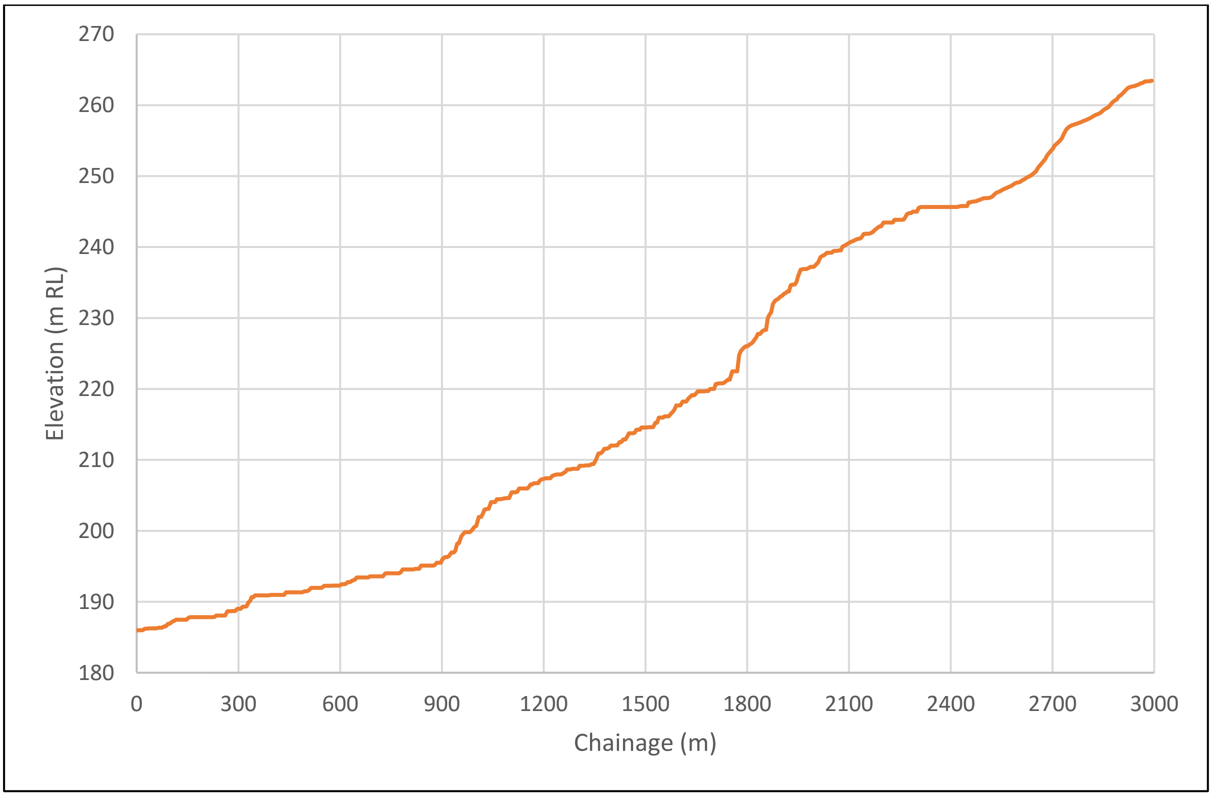
A number of methods are available to model the transformation of excess precipitation to runoff. We note that NRC does not appear to have a preferred method for the region, however, the Priority Rivers Modelling Report (URS, 2011) used the SCS Unit Hydrograph method, and it is also used with TP108.

For the purposes of this assessment we have used the SCS Unit Hydrograph method, along with a Peak Rate Factor of 484 (PRF 484). PRF 484 is the standard factor used. Other factors are available which result in peakier or flatter runoff hydrographs. Without any observed events to calibrate to for the catchment, we consider that a PRF of 484 is the most appropriate to use.

10.5 Time of Concentration

Figure 7 presents a long section along the longest flow path to the dam site from the upstream reaches of the watercourse. The maximum elevation with the catchment is RL 372m. The average gradient of the catchment was estimated to be approximately 2.6%.

Figure 7: Longest Flow Path Long Section



We have used various methods to estimate the time of concentration as presented within Table 19. The methods generally use flow path length, catchment area and elevation change as input parameters. The TP108 method was specifically derived for Auckland catchments.

Table 19: Time of Concentration (Minutes)

Method	Value
Ramser Kirpich	40
Bransby Williams	80
TP108	73

The Bransby Williams and TP108 methods provide similar results. We consider that the use of a time of concentration of 75-minutes is appropriate. The SCS unit hydrograph method uses lag time as the input parameter instead of time of concentration, where the lag time is equal to two thirds of the time of concentration. Therefore, a lag time of 50-minutes has been used within the assessment.

10.6 Rainfall Depth

10.6.1 Design Rainfall Depths

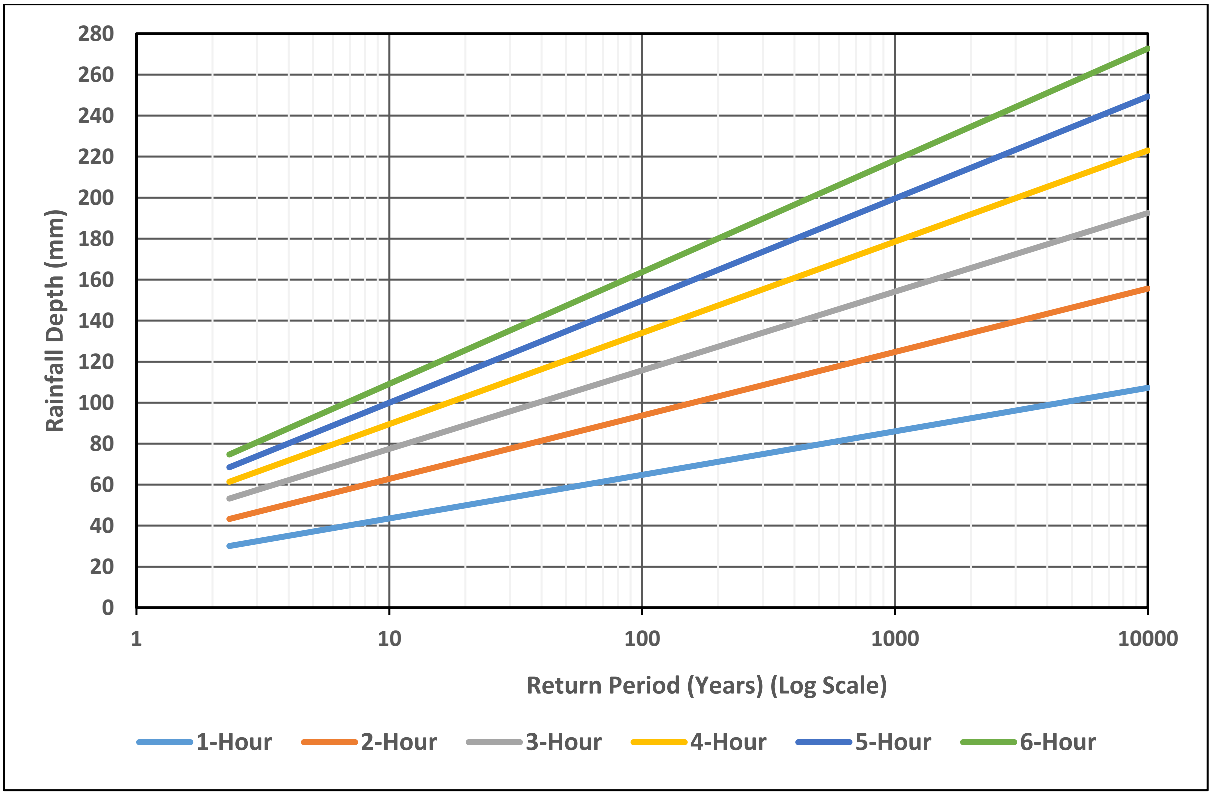
We consider extrapolations of the High Intensity Rainfall Design Systems (HIRDS) data provides the best estimate of rainfall depths up to the 10,000-year event at this time.
Table 20 provides a summary of the selected rainfall depths for the full range of rainfall durations.

Table 20: High Intensity Rainfall Design Systems Rainfall

Rainfall Event	Duration (hours)						6 to 1 Hour Ratio
	1	2	3	4	5	6	
2.33-Year	30	43	53	61	68	75	2.5
100-Year	65	94	116	134	150	164	2.5
250-Year	73	106	131	152	170	185	2.5
1,000-Year[1.]	86	125	154	179	200	218	2.5
10,000-Year[1.]	107	156	192	223	249	273	2.5

Note: [1] Extrapolated on a log scale

Figure 8: Design Rainfall Depths



10.6.2 Probable Maximum Precipitation

Thompson and Tomlinson (1993) provides a methodology for estimating Probable Maximum Precipitation (PMP) depths for rainfall durations from 0.5-hour through to 6-hours. It uses a baseline point value of 220mm for rainfall durations of 1-hour and allowances are subsequently made for catchment area, catchment elevation, moisture potential (values generally reduce from north to south in New Zealand). We determined a 1-hour PMP of 205mm, based on a catchment area of 3.1km^2 and without any adjustments for catchment elevation and moisture potential. Using the Thompson and Tomlinson (1993) methodology, the 1-hour PMP depth is factored to other durations by selecting an appropriate 6-hour to 1-hour ratio. We have conservatively selected a ratio of 2.5, noting that the HIRDS information indicates an approximate ratio of 2.5. Table 21 presents the PMP depths used within the assessment, along with the ratios used as recommended by Thompson and Tomlinson (1993).

Table 21: Probable Maximum Precipitation Depths

Duration (hour)	Ratio to 1 Hour Duration	PMP (mm)	New Zealand Record (mm)[1.]	Australian Record (mm)[2.]
1	1.00	205	134	230
2	1.42	291	-	-
3	1.75	359	-	-
4	2.03	416	-	-
5	2.27	465	-	-
6	2.50	512	-	589
12	-	-	566	-

Note:

1. Sourced from NIWA (up until 31 December 2016).
2. Sourced from Australian Government Bureau of Meteorology.

The predicted PMP rainfall depths compare favourably with the New Zealand records. We have also included some Australian records for comparison. One of the largest recorded flood events in the Northland Region is the 1981 Kerikeri flood. Approximately 450mm of rainfall occurred in approximately 8-hours. We note that this event was not included within the dataset for Thompson and Tomlinson (1993). The determined six-hour PMP rainfall depths compares favourably with this event.

10.7 Temporal Distribution

There are a number of options available for the temporal distribution of the design rainfall depths as outlined below:

1. NRC Priority Rivers Hyetograph.
2. HIRDs Standard Project Storm Hyetograph.
3. Hyetograph from locally recorded rainfall events.

Figure 9 provides a comparison of the derived temporal distributions from the Priority Rivers method and the HIRDs method. We note that Thompson and Tomlinson (1993) does not provide a method for the temporal distribution of the total rainfall depth.

The HIRDS method has been derived hyetographs shapes for different regions within New Zealand. The area of interest is located in the north of the North Island Region. Parameter values are provided for use within a formulas for different durations. The two most relevant durations for this catchment are the 1-hour and 6-hour durations. The NRC Priority Rivers hyetograph was developed in 2010/2011 and uses a 12-hour duration event as a basis. We understand that a recent draft review for NRC has recommended that the HIRDS hyetograph be used in the short term as a replacement for the Priority Rivers hyetograph.

For the purposes of this assessment we consider that the HIRDS hyetograph is the preferred approach, noting that it has been developed on a regional basis for specific durations in the order of those that will be critical for this catchment (i.e. 1-hours to 6-hours). HIRDS provides different parameters for the 1-hour and 6-hour events. Figure 10 presents the different distribution for the 1-hour and 6-hour events. The critical events for the catchment are likely to be somewhere between the 1-hour and 6-hour event, however, we have elected to use the 6-hour parameters for all assessed durations, as we consider that the critical duration events are likely to be closer to 6-hours.

Figure 9: Temporal Distribution Comparisons

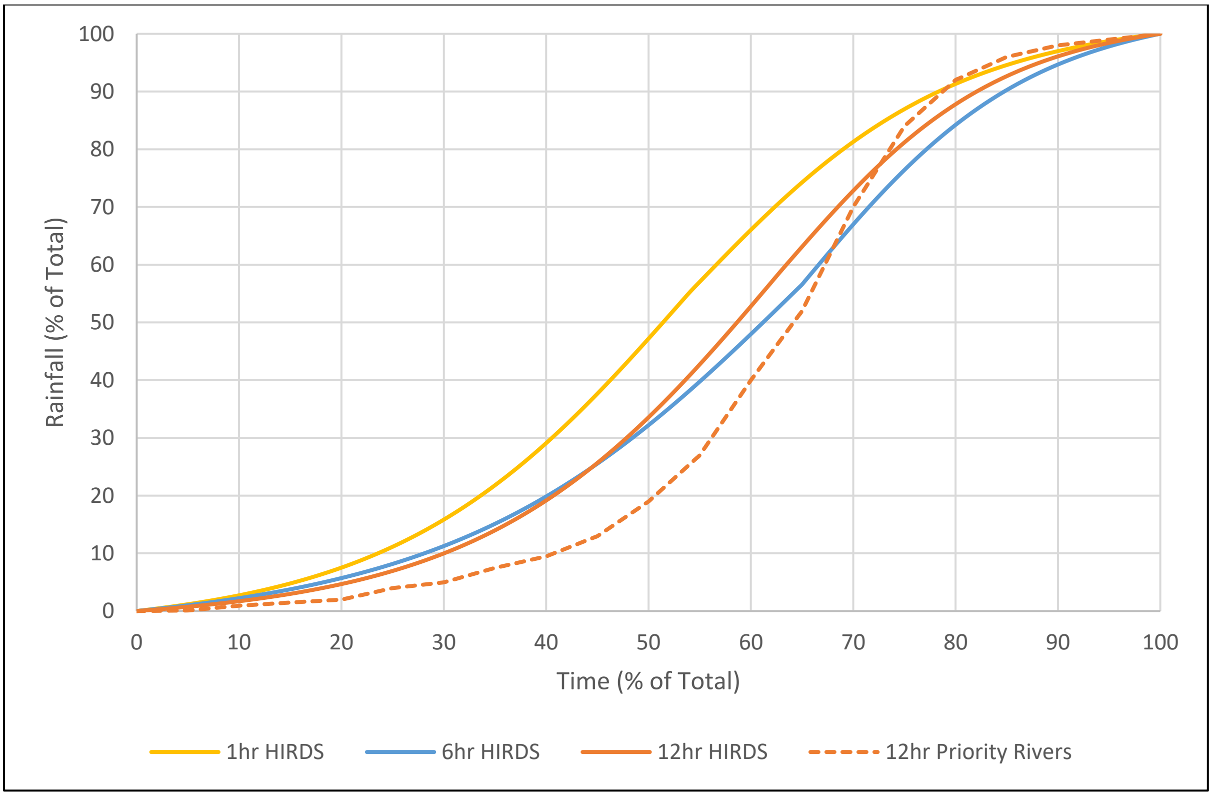
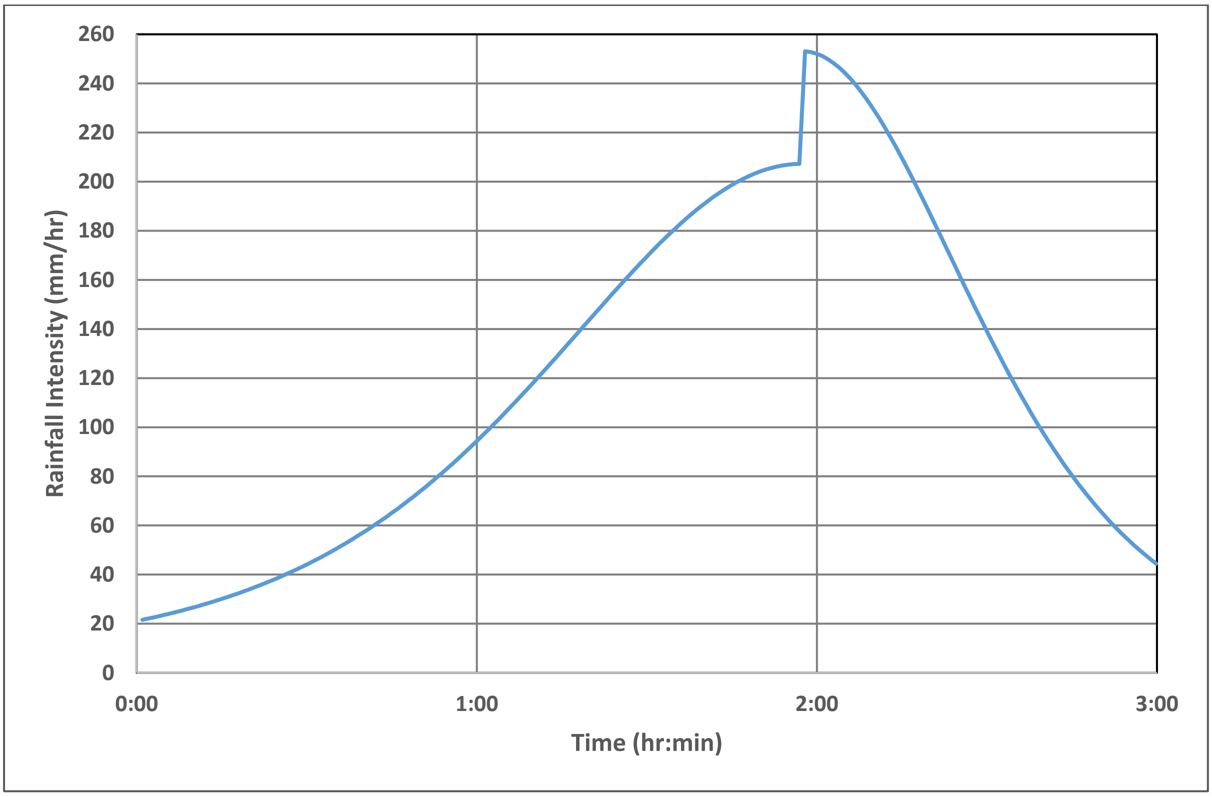


Figure 10 presents the design PMP 3-hour rainfall hyetographs.

Figure 10: PMP 3-Hour Rainfall Hyetographs



10.8 Inflow Design Hydrographs

A HEC-HMS rainfall-runoff model has been developed with a single sub-basin utilising the input parameters detailed in the previous sections. The model results are presented within Table 22, with the critical durations highlighted in red.

Table 22: Rainfall Runoff Model Peak Flow Results

Event			Duration (hr)				
	2	3	4	5	6	7	8
2.33-Year	-	-	9.6	10.0	10.2	10.1	10.0
100-Year	-	-	31.3	31.5	31.2	30.5	-
10,000-Year	-	59.4	60.8	60.1	58.6	56.8	-
PMF	118.9	126.7	126.6	123.1	119.5	-	-

10.9 Regional Methods

McKercher and Pearson (1989) presents a regional method for determining mean annual and 100-year flood magnitudes. The results of the assessment are summarised in Table 23.

Table 23: McKerchar and Person Regional Method

Value	Dam Site
$Q_{2.33}/A^{0.8}$	5.0
$Q_{2.33}$ (m^3/s)	12.4
q_{100}	2.7
Q_{100}	33.4

A revised regional method is the New Zealand River Flood Statistics GIS portal. The information indicates that the mean annual flood slightly downstream of the proposed dam site (3.66km^2 catchment) is 4.0m^3/s with a 100-year flow of 10.0m^3/s (a Q_{100}:$Q_{2.33}$ ratio of 2.5).

10.10 Observed Flood Events

We have not reviewed observed flood events specifically at the site as it is outside the scope of the assessment. However, on a regional basis, we note that during the 1981 Kerikeri event the estimated flow at the Maungaparerua gauge was 184m^3/s equating to a specific discharge of 16.5m^3/s/km^2 for a catchment area of 11.1km^2 (NIWA 2009). The flow was estimated to have a return period of close to 1,000-years i.e. the event was extreme. We note, however, that there is some uncertainty associated with the estimated peak 1981 flows (as well as the maximum rainfall). We also note that NIWA 2009 states that on the basis of rainfall records from the Kerikeri storm, the existing New Zealand PMP estimates may be too low.

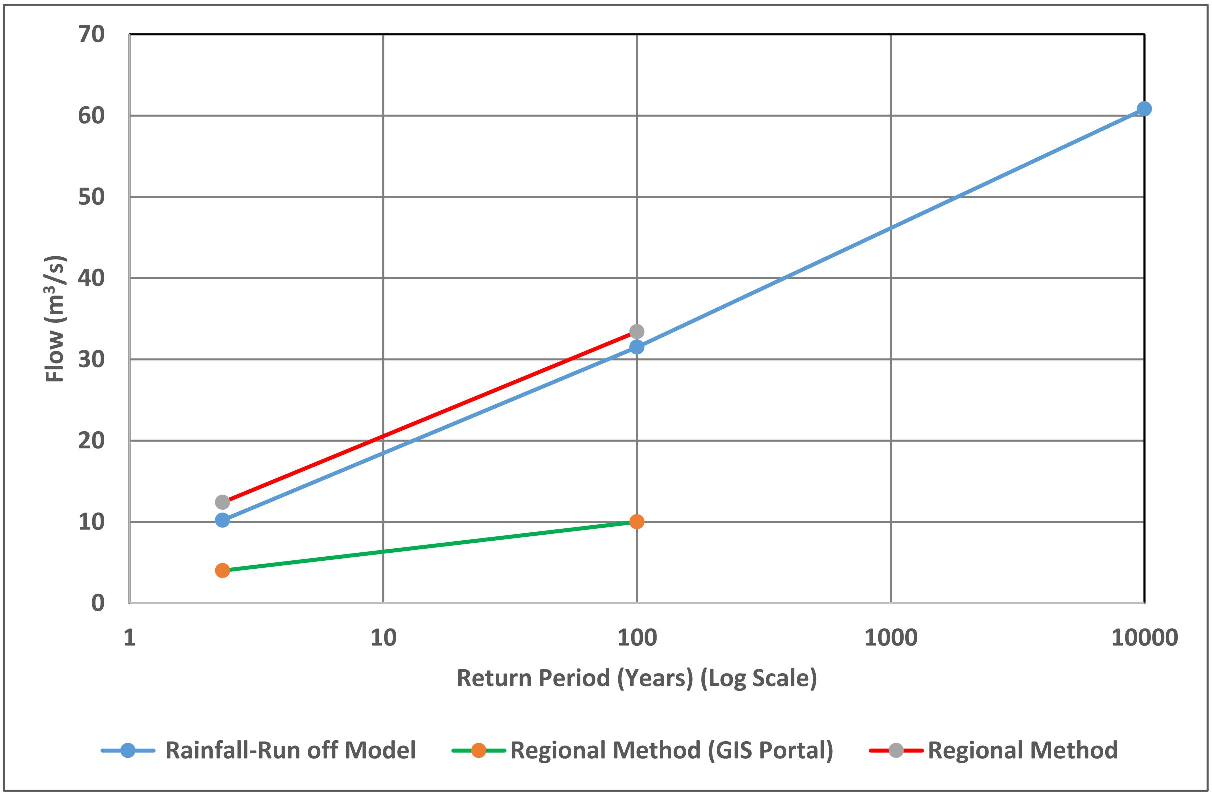
10.11 Summary

Table 24 presents a summary of the peak inflows derived using the various methods. The results are also presented in Figure 11 (with a log scale).

Table 24: Peak Flow Results (m^3/s)

Method	2.33-Year	100-Year	10,000-Year	PMF	Q_{100}:$Q_{2.33}$ Ratio
Rainfall-Runoff Model	10.2	31.5	60.8	127	3.1
Regional Method New Zealand River Flood Statistics GIS portal	4.0	10.0	-	-	2.5
Regional Method McKercher and Pearson (1989)	12.4	33.4	-	-	2.7

Figure 11: Peak Flow Results



The New Zealand River Flood Statistics GIS portal appears to underestimate the mean annual flood and therefore the 100-year flood (noting that the Q_{100}:$Q_{2.33}$ ratio of 2.5 is comparable to other methods).

For the proposes of this assessment, we consider that the rainfall-runoff model provides appropriate inflow design hydrographs.

11.0 Spillway Design

11.1 Design Criteria

The adopted design criteria is summarised in Table 25.

Table 25: Design Criteria

Element	Criteria
Service Flood	100-year flood event to be passed with very low-probability of erosion within the spillway arrangement.
Design Flood	PMF flood event to be passed with adequate freeboard to the dam or wave wall crest. Freeboard the greater of 900mm or the sum from the wind set up and wave run up from the 10% annual exceedance probability (AEP) wind.
Construction Diversion	Less than 2% probability of the partially completed dam being overtopped.

11.2 Methodology

We have used HEC-RAS (v5.07) to simulate the hydraulic performance of the reservoir and spillway.

11.3 Geometry and Spillway Design

The reservoir has been modelled as a 2D flow area. The 2D flow area is connected to a downstream 2D flow area via a connection represented by the spillway crest.

For the purposes of the preliminary design we have assumed that there is a single overflow spillway. During detailed design, a dual spillway arrangement may be considered, with a service and an auxiliary spillway. The primary spillway will be designed to have a low risk of erosion during more frequent and smaller magnitude flood events. The spillways will be located entirely within natural ground.

The preferred spillway location is on the right abutment, with the spillway discharging to the Pekapeka Stream approximately 100m downstream of the dam toe. The preliminary spillway has been designed with a sill elevation of RL 205.0m and a lower sill width of 10m and an upper sill width of 30m at RL 205.5m (total spillway width of 40m). The spillway design was incorporated into the 5m DEM described previously.

The downstream 2D flow area extends from the spillway entrance to a point approximately 800m downstream of the dam. A refinement region with a grid size of 0.5m by 0.5m has been used within the spillway chute.

We have used a Manning's 'n' value of 0.03 to reflect a grassed lined spillway. Future detailed design may consider the use of a concrete chute spillway or a combination of a concrete chute and grassed lined. Erosion protection at the downstream toe of the chute will also need to be considered. We envisage that riprap lining will be adequate.

11.4 Initial Condition

We have used an initial condition of RL 205.0m for the reservoir 2D flow area.

11.5 Upstream Boundary Condition

The results from the HEC-HMS model have been used as inflow hydrographs to the reservoir.

11.6 Downstream Boundary Condition

We have used the normal depth calculation method with a friction slope of 0.002, to correspondence with the general longitudinal gradient of the terrain in the region of the downstream boundary location.

We do not consider the downstream boundary condition is critical to the assessment as the boundary location is sufficiently downstream of the area of interest at the downstream toe of the dam.

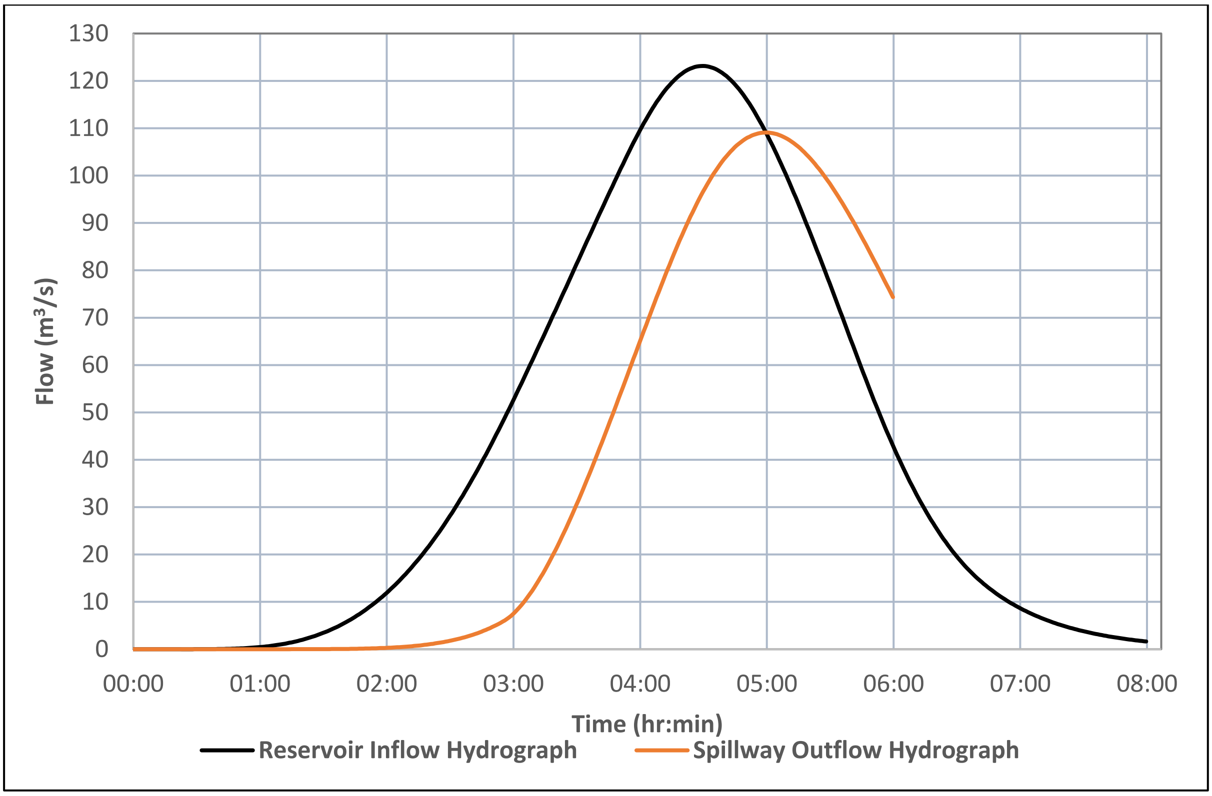
11.7 Reservoir Results

The critical duration was found to be 5 hours for the PMF event, with a peak reservoir level of RL 206.8m (rounded up to the nearest 0.1m).

The proposed dam embankment crest level is RL 207.0m. The model results indicate that a 700mm high wave wall is required to provide 900mm freeboard. During future detailed design, the spillway arrangement and dam crest level may be able to be optimised further. Sensitivity analysis should also be undertaken including assessing the available freeboard.

The reservoir inflow and outflow hydrographs are presented in Figure 12. The peak inflow of 123m^3/s is attenuated by the reservoir to a peak outflow of 109m^3/s.

Figure 12: PMF Flow Hydrographs



11.8 Velocity Considerations

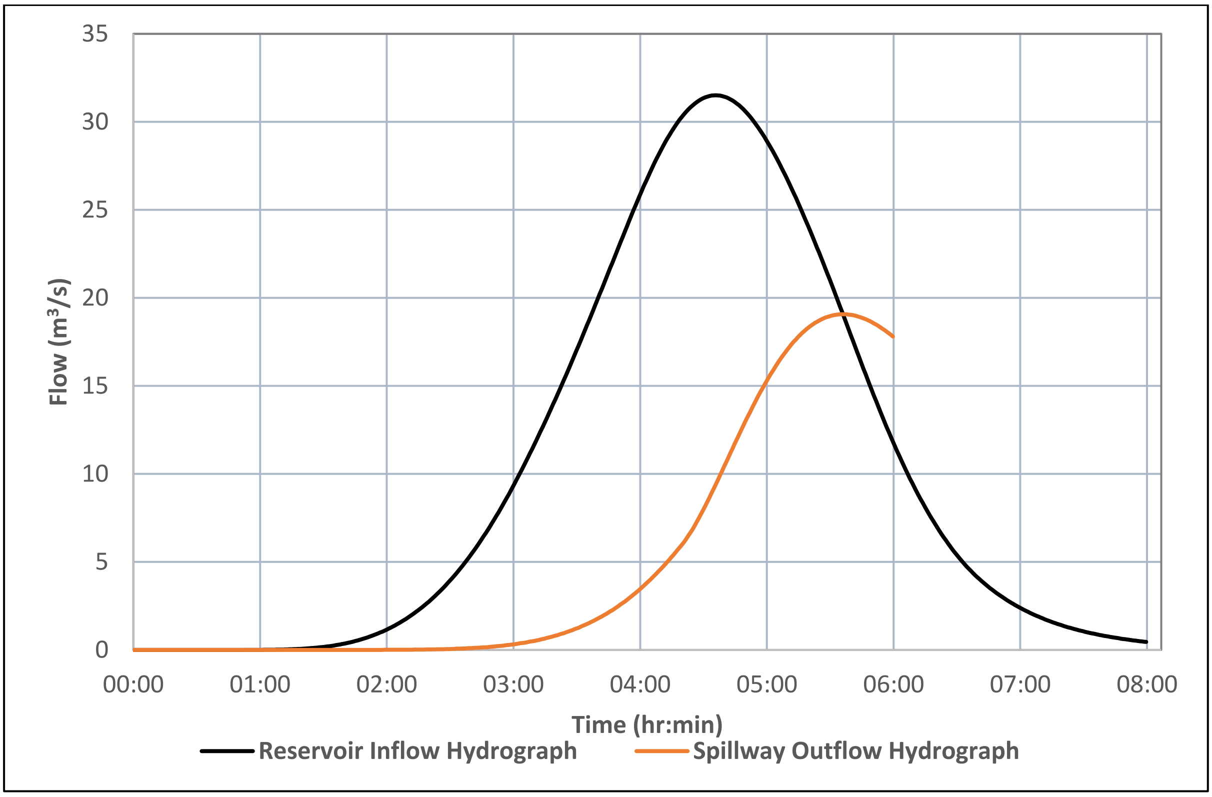
Preliminary results indicate that velocities within the spillway chute may reach 10m/s depending on the final longitudinal profile, during the PMF event. We therefore consider that at least the service spillway chute will be constructed from concrete to provide adequate erosion protection. Erosion protection will also be required at the toe of the spillway, where the transition to the stream occurs.

12.0 Flood Attenuation

A secondary objective of the proposed dam design is the capacity to attenuate peak flows from the catchment. The effect of this is a reduction in the flooding experienced by the downstream community.

The most relevant events to assess when considering flood attenuation are events in the order of the 100-year event, as larger events are less relevant to communities. The attenuation provided during the critical 5 hours duration 100-year event is presented within Figure 13.

Figure 13: 100 Year Flow Hydrographs



The peak inflow of 32m^3/s is attenuated by the reservoir to a peak outflow of 19m^3/s. The reduction of peak flow through the spillway is approximately 40% of the inflow which will significantly reduce the downstream flooding. We note that if the reservoir level is below the full supply level prior to the rainfall event, the attenuation provided by the dam would be increased, further reducing downstream flooding.

13.0 Diversion During Construction

The stream needs to be diverted during construction to provide a dry working area during construction and also to prevent the overtopping of a partially formed embankment. We have taken a risk-based approach to the diversion design as recommended by the NZSOLD Guidelines i.e. at lower dam heights the likelihood of overtopping is higher, however, the downstream consequence an embankment breach is lower. The construction cost risk has not been specifically considered, as it is intended that the contractor’s construction insurance will cover the cost in this event. There is no public safety risk from a breach during foundation works.

The design intent is to construct the diversion culvert offline from the existing stream. When the culvert is completed, the creek will be diverted into the culvert, and the upstream shoulder of the dam will be preferentially constructed ahead of the downstream area, to form a cofferdam.

The NZSOLD Guidelines do not provide specific guidance on acceptable risk, however, it does state that “if the incremental consequences of a dam failure during construction include no potential for the loss of life downstream of the dam, a return period of 50-years may be appropriate for the sizing of the diversion works”. Given appropriate monitoring and warning systems will be in place, we consider that the potential for loss of life is minimal.

Preliminary calculations indicate that a 1500mm to 1800mm dimeter culvert will have sufficient capacity to pass the 50-year flood. Further assessments will be required at detailed design stage, potentially including an analysis of floods with lower likelihood of occurring but with higher downstream consequences. The risk associated with the dam construction will vary throughout construction period.

14.0 Intake Details and Fish Passage

The following section includes details of the intakes and approach to fish passage.

Puhoi Stour completed a preliminary ecology assessment at Te Ruaotehauhau Water Storage Reservoir in July 2020 and has provided draft results indicating the potential effects from the proposed dam. Key issues that need to be considered in the design of the dam in regard to fish passage include:

- Migration of eels (elvers) upstream during peak migration periods (summer). Tuna (longfin eel) was the only migratory species found at the site. These elvers are <200mm in size (typically 100mm) and are good climbers even with minor flows.
- Consideration for downstream movement of migrant eels should, however, be included in spillway design to minimise the potential for injuries to occur.
- From the proposed Regional Plan water intakes will need screens with 3mm mesh and velocities into the screen of less than 0.12m/s based on Canterbury Guidelines.

We note that inanga, a native at-risk and migratory species, were found in the downstream extent of the site. They were not found in the upstream extent of the site and Puhoi Stour have assessed that any modification of access to the headwaters will not affect their lifecycle.

14.1 Upstream Migration of Elvers

The principal challenge with upstream passage is that the reservoir will have a large operating level range across the irrigation season. When the reservoir is full the barrier is 20m high for the elvers to climb to and the range from full to empty is challenging to design for. An elver pass may be feasible with a floating intake to operate in the upper few metres of the range but is not considered feasible for the entire operating level of the dam. When the reservoir water level is below the operating level of the elver pass then a trap and transfer system could be utilised to manage the upstream migration of eel.

Alternatively, a trap and transfer of elver could be undertaken without the construction of an elver pass. This involves a trap installed near the downstream toe of the embankment, within which the elvers enter via a short crawling medium into a holding tank. These are then physically transported and released over the dam. This would be located with a pass a minimal distance above the downstream water level to maximise the reservoir water level range it would operate over. The concept is the flow down the crawling medium attracts the elvers and excludes other unwanted species. If this approach were adopted the source of water could be via the dam and into the trap via the residual flow. The trap and transfer may only operate over peak migration, but adaptive management approach could be used in developing an efficient programme. This option has been used successfully on other large dam projects and therefore provides the greatest chance of success. An example of the elver trap used at Matahina Dam is shown in Photo 3.

Photo 3: Matahina Elver Trap

Another option is a trap pass system with a crawling medium all the way up to the dam crest. The system would enable the elvers to pass without intervention and a schematic is presented in Figure 14. Resting pools would be required at regular intervals up the slope, and a climbing medium would need to span the elver pass to allow elvers to attach. An open channel or frictionless chute such as a plastic pipe would then deliver the elvers to the reservoir and avoid elvers climbing back up. Figure 15 presents some indicative details. A continuous water supply would need to be pumped from the reservoir, albeit this would likely be small.

Figure 14: Schematic of trap pass

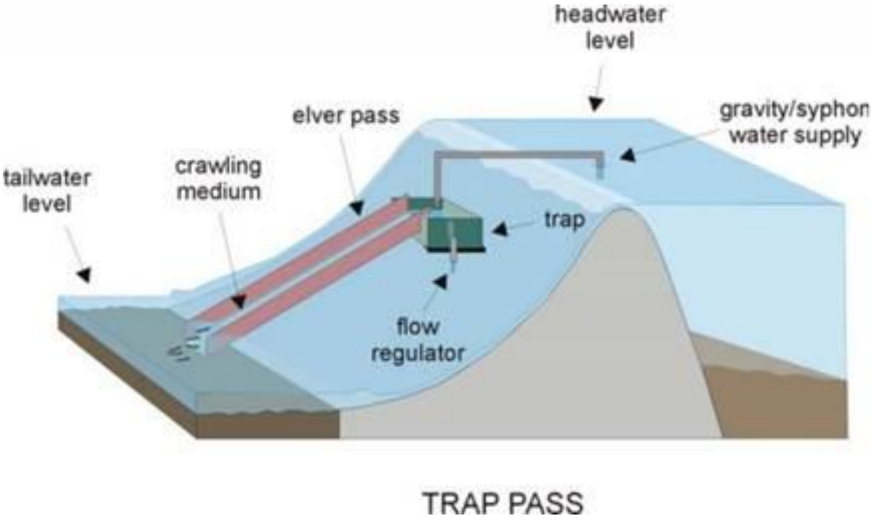
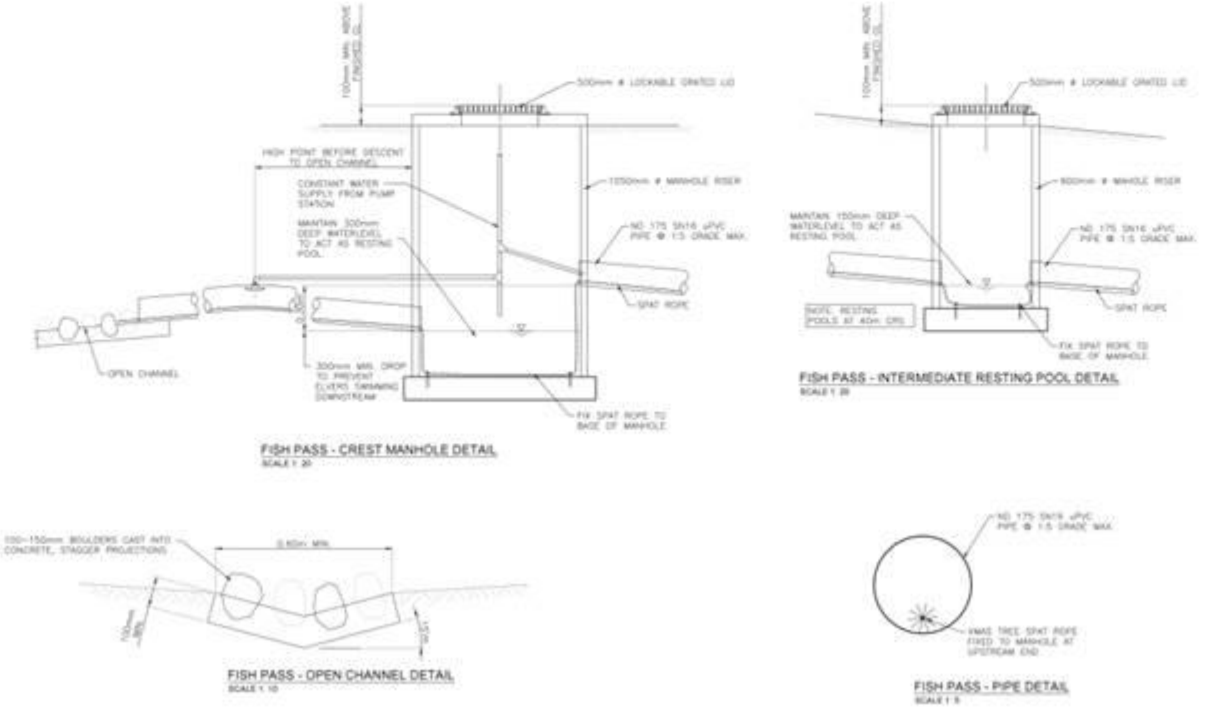


Figure 15: Typical details of trap pass



The nature of both an elver pass and trap and transfer are challenging, and it is likely that some modifications to the pass or the trap and transfer process will be required during operation. Monitoring of the effectiveness will need to be undertaken and where required modifications to resolve any issues implemented.

14.2 Spillway Design for Downstream Adult Eel Migration

The shaping of a spillway channel and downstream structures that are part of the spillway will consider what is required to minimise damage to eel. This will relate to depth of flows and any structures with the flow channel downstream and back to the river.

14.3 Intake and Screens

The dam will operate with both a residual flow requirement and an irrigation supply requirement. This will likely involve two separate smaller pipes housed within a larger pipe that also acts as temporary flood diversion during dam construction. Both smaller pipes will require a valve and flow meter to control and measure the flows released. The larger pipe will be provided with a gate to enable emergency dewatering of the reservoir. The intake will need to include a screen to comply with proposed regional plan to keep fish in the stream and also to avoid impingement onto the screen. This includes a requirement of a 3mm mesh screen. Given the small gaps in the screen there is a risk of the screen blocking and therefore, likely that a cleaning system will also be required. If the intake is a single intake located at the invert of the pond, then a rotary or retrievable screen may be used to ensure the screen is kept clean. Specific safety measures will be included that enable the reservoir level to be controlled and maintained in future.

15.0 Summary

The main findings and recommendations contained within this report are summarised as follows:

- A hydraulic model of a sunny day dam breach scenario and a subsequent PIC assessment indicates that the proposed dam has a High PIC. A rainy day scenario should be considered at detailed design stage.
- We consider that the design flood event should be the PMF.
- A preliminary spillway design has been prepared to ensure that adequate freeboard to the dam crest (including a wave wall) is maintained during the design flood event. Sensitivity analysis should be considered at detailed design stage.
- The spillway arrangement may be optimised further during detailed design. Erosion protection will also be considered further.
- The dam will provide significant flood attenuation for flood events up to and including the 100-year flood event.
- Stream diversion during construction will be managed through the preferential construction of the upstream shoulder of the dam to form a cofferdam.
- Preliminary calculations indicate that a 1500mm to 1800mm dimeter culvert will have sufficient capacity to pass the 50-year flood during construction. Further assessments will be required at detailed design stage.
- Methods to allow for fish passage upstream and downstream of the dam have been outlined. Further assessments to identify the most appropriate method will be required at detailed design stage.

16.0 Limitation

This report has been prepared solely for the benefit of Te Tai Tokerau Water Trust as our client with respect to the brief and Northland Regional Council in processing the consent(s). The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

The hydrological and hydraulic analyses and recommendations contained in this report are based on our understanding and interpretation of the available information. The recommendations are therefore subject to the accuracy and completeness of the information available at the time of the study. Should any further information become available, the analyses and findings of this report should be reviewed accordingly.

APPENDIX A

HEC-RAS Summary

HEC-RAS Model Overview: MiD North MN-06 Dam

Model Location:
T:\2020 Jobs\200240 Northland WSUP Feasibility Study\4.0 DESIGN-INVEST\4.3 Wat\Dam Break modelling\MN06\HEC-RAS

Created By:	HA
Checked by:	GL

Version	5.0.7
Projection	New Zealand Transverse Mercator 2000
Vertical Datum	NZVD 2016
Geometry Files	Sunny Day Piping
	PMF 5hr Spillway V3
	100YR 5hr Spillway
Terrain	5m 2017 LiDAR
	TOPO, DAM & Spillway Combined DEM V2
Unsteady Flow Files	Sunny Day Inflow
	PMF 5-Hour Reservoir Inflows
	100YR 5-Hour Reservoir Inflows

Plans	**Plan**	**Unsteady Flow Files**	**Geometry Files**
1	Sunny Day - Piping	Sunny Day -Piping	Sunny Day Piping
2	PMF 5hr Spillway V3	PMF 5-Hour Reservoir Inflows	PMF 5hr Spillway V3
3	100YR 5hr Spillway	100YR 5-Hour Reservoir Inflows	100YR 5hr Spillway

Model Input Details

Geometry Files

Geometry File:	Sunny Day Piping		PMF 5hr Spillway V3		100YR 5hr Spillway	
2D Flow Areas:						
Name:	MN-06 Reservoir	DS 2D AREA	Reservoir	Spillway 2D Area	Reservoir	Spillway 2D Area
Mannings n:	N/A	0.06	0.03	0.03	0.03	0.03
Grid Size:	E-V Curve	5m x 5m	10m x 10m; One 0.5x0.5m Refinement	5m x 5m; One 0.5x0.5m Refinement	10m x 10m; One 0.5x0.5m Refinement	5m x 5m; One 0.5x0.5 Refinement
Terrain Association:	5m 2017 LiDAR		TOPO, DAM & Spillway Combined DEM V2		TPO, DAM & Spillway Combined DEM V2	

Connections

Geometry File:	Sunny Day Piping	PMF 5hr Spillway V3	100YR 5hr Spillway
Name:	MN-06 DAM	Spillway	Spillway
Weir Width (m):	470.851	62.291	62.291
Weir Coefficient:	1.43	1.7	1.7
Weir Crest Shape:	Broad Crested	Broad Crested	Broad Crested
Overflow Computation Method:	Use Weir Equation	Use Weir Equation	Use Weir Equation
Structure Type:	Weir, Gates, Culverts, Outlet RC and Outlet TS	Weir, Gates, Culverts, Outlet RC and Outlet TS	Weir, Gates, Culverts, Outlet RC and Outlet TS
Embankment Station/Elevation Table:	Generated from DEM -Variable Elevation	Design Variable Cross Section	Design Variable Cross Section
Weir Level:	Variable with minimum RL 207m	Variable with minimum RL 205m	Variable with minimum RL 205m
Dam Breach:	Yes	N/A	N/A
Final Bottom Width:	14.7	N/A	N/A
Final Bottom Elevation:	185.3	N/A	N/A
Side Slope (V:H):	1:0.7	N/A	N/A
Breach Weir Coefficient:	1.7	N/A	N/A
Breach Formation Time (Minutes):	18	N/A	N/A
Failure Mode:	Piping	N/A	N/A
Piping Coefficient:	0.3	N/A	N/A
Initial Piping Elevation:	190.5	N/A	N/A
Trigger Failure At:	Set Time	N/A	N/A
Starting Date and Time:	05Aug2120 00:01	N/A	N/A

Unsteady Flow Files

Unsteady Flow Files:	Sunny Day Piping		PMF 5-Hour Reservoir Inflows		100YR 5-Hour Reservoir Inflows	
Storage/2D Flow Areas:	MN-06 Reservoir	DS 2D AREA	Reservoir	Spillway 2D Area	Reservoir	Spillway 2D Area
Boundary Condition:	Initial Condition	DS BC	Inflow Hydrograph	DS BC	Inflow Hydrograph	DS BC
Type:	Storage Area	Normal Depth	Timeseries Flow	Normal Depth	Timeseries Flow	Normal Depth
Enter Table:	N/A	N/A	✓	N/A	✓	N/A
Use Simulation Time:	N/A	N/A	Fixed Time	N/A	Fixed Time	N/A
Data Time Interval:	N/A	N/A	1 minute	N/A	1 minute	N/A
EG/Friction Slope:	N/A	0.00507	0.00001	0.00222	0.00001	0.00222
Data:	N/A	N/A	Generated from HEC-HMS	N/A	Generated from HEC-HMS	N/A
Initial Elevation /Value:	205.00	N/A	205.00	N/A	205.00	N/A

Plans

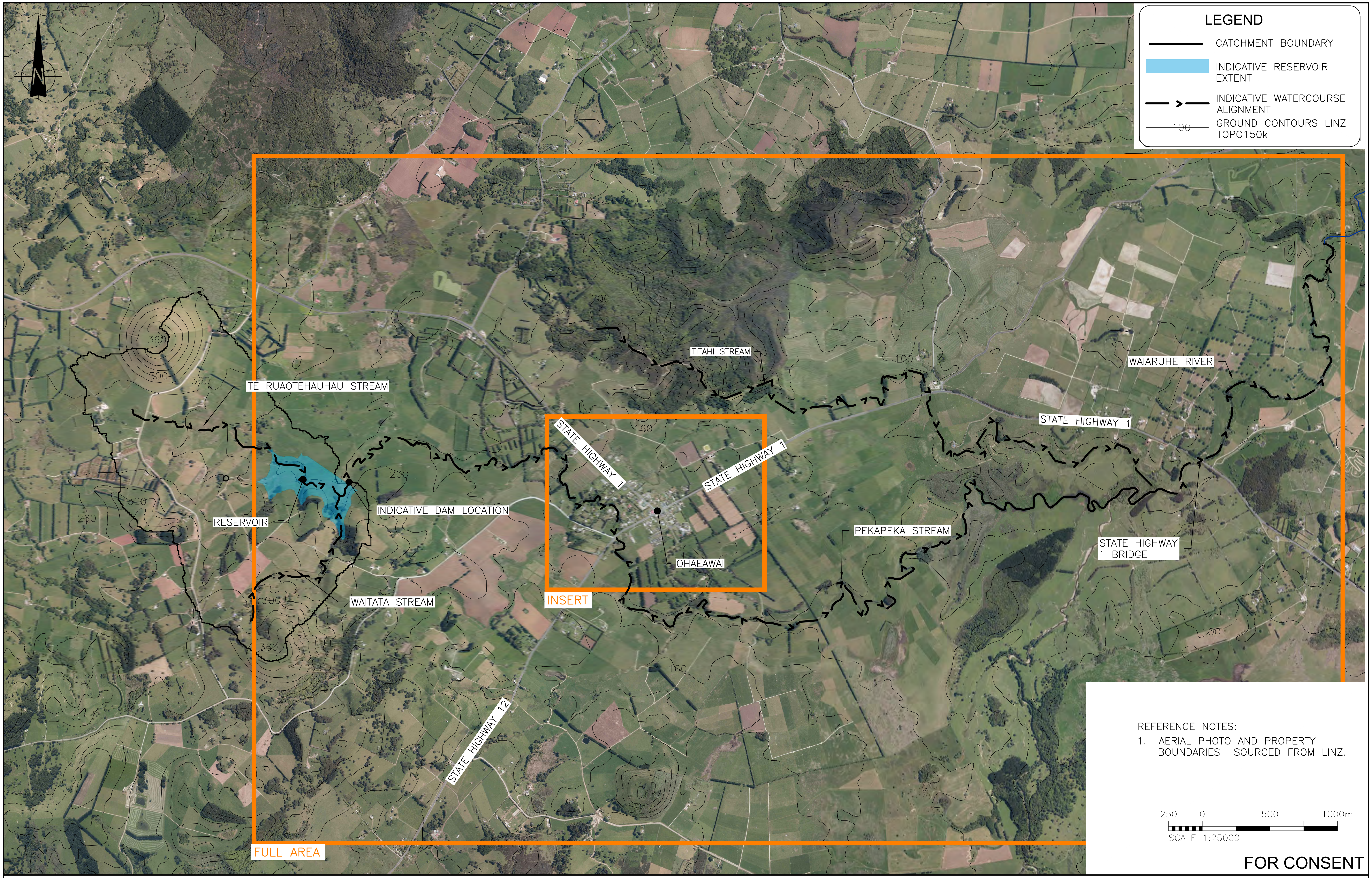
Plan:	Sunny Day - Piping	PMF 5hr Spillwqay V3	100YR 5hr Spillway
Geometry Preprocessor:	✓	✓	✓
Unsteady Flow Simulation:	✓	✓	✓
Post Processor:	✓	✓	✓
Starting Date:	5/08/2120	5/08/2120	5/08/2120
Starting Time:	0:00	0:00	0:00
Ending Date:	5/08/2120	5/08/2120	5/08/2120
Ending Time:	6:00	3:00	3:00
Computational Interval:	Vaiable time step	Vaiable time step	Vaiable time step
Mapping Output Interval:	1 minute	1 minute	1 minute
Hydrograph Output Interval:	1 minute	1 minute	1 minute
Detailed Output Interval:	1 minute	1 minute	1 minute
Equation Set:	Full Momentum	Diffusion Wave	Diffusion Wave

Model Output Details

Plan:	Sunny Day - Piping				PMF 5hr Spillway V3/100YR 5hr Spillway		
Layer Name:	WSE	Depth	Velocity	D * V	WSE	Depth	Velocity
Type:	Water Surface Elevation	Depth	Velocity	Depth * Velocity	Water Surface Elevation	Depth	Velocity
Unsteady Profile:	Maximum	Maximum	Maximum	Maximum	Maximum	Maximum	Maximum
Stored (saved to disk):	Raster Based on Terrain	Raster Based on Terrain	Raster Based on Terrain	Raster Based on Terrain	Raster Based on Terrain	Raster Based on Terrain	Raster Based on Terrain
Item:	5m 2017 LiDAR	5m 2017 LiDAR	5m 2017 LiDAR	5m 2017 LiDAR	TOPO, DAM & Spillway Combined DEM V2		

APPENDIX B

Drawings



REFERENCE NOTES:

1. AERIAL PHOTO AND PROPERTY BOUNDARIES SOURCED FROM LINZ.

FOR CONSENT

REV	DATE	ISSUE	BY
1		FOR CONSENT	OBG

DESIGN	DES CHECK	APPROVED FOR ISSUE
GL	GL	D TATE
DRAWN	CAD CHECK	
OOBG	JM	
DATE DRAWN		ISSUE DATE
AUG. 2020		01 / 09 / 20

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CLIENT	TE TAI TOKERAU WATER TRUST
ADDRESS	NORTHLAND
PROJECT	TE RUAOTEHAUHAU WATER STORAGE RESERVOIR
SHEET TITLE	DOWNSTREAM FLOODPLAIN OVERVIEW

ACENZ
ISO CERTIFIED GCS

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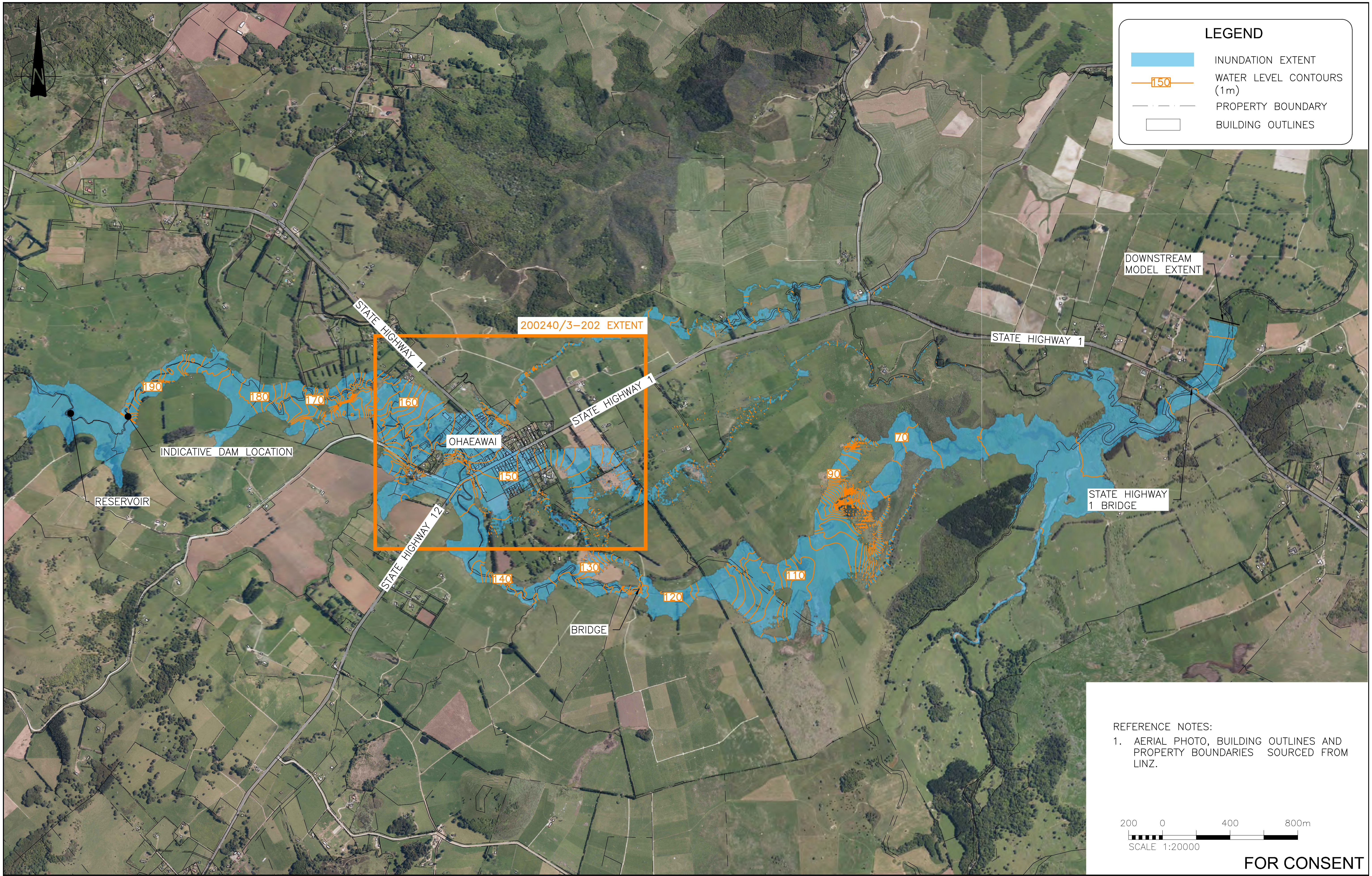
DRAWING No.	REV.
200240/3-200	1



LEGEND

🟦	INUNDATION EXTENT
150	WATER LEVEL CONTOURS (1m)
— · — · —	PROPERTY BOUNDARY
☐	BUILDING OUTLINES

REFERENCE NOTES:

1. AERIAL PHOTO, BUILDING OUTLINES AND PROPERTY BOUNDARIES SOURCED FROM LINZ.

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REV	DATE	ISSUE	BY
1		FOR CONSENT	OBG

DESIGN GL	DES CHECK GL	APPROVED FOR ISSUE D TATE
DRAWN OOBG	CAD CHECK JM	
DATE DRAWN AUG. 2020		ISSUE DATE 01 / 09 / 20

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CLIENT	TE TAI TOKERAU WATER TRUST
ADDRESS	NORTHLAND
PROJECT	TE RUAOTEHAUHAU WATER STORAGE RESERVOIR
SHEET TITLE	SUNNY DAY BREACH - PEAK LEVELS (FULL AREA)

ACENZ

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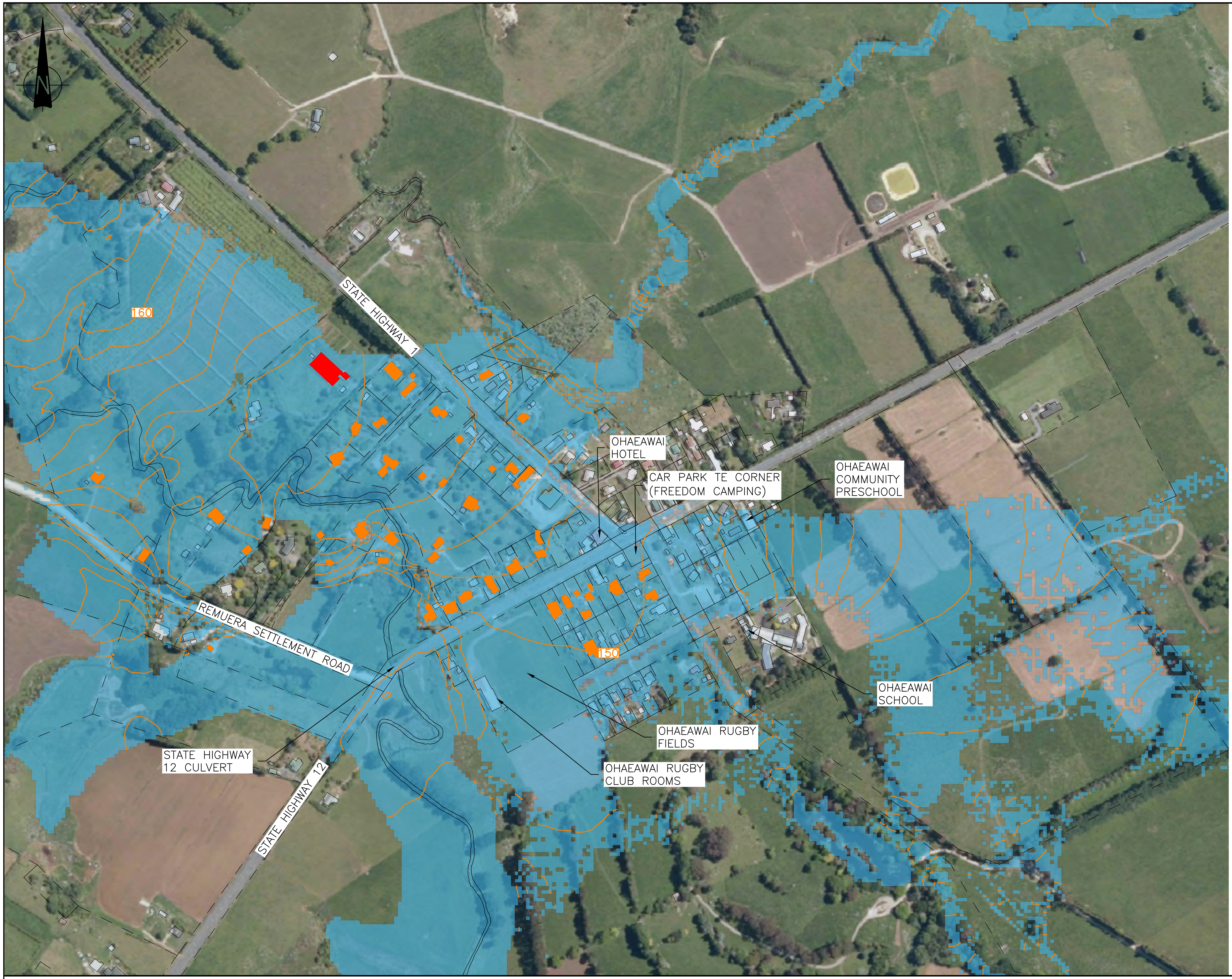

LEGEND

🟦	INUNDATION EXTENT
150	WATER LEVEL CONTOURS (1m)
— · — ·	PROPERTY BOUNDARY
☐	BUILDING OUTLINES
🟧	RESIDENTIAL HOUSE INUNDATED BY DEPTHS >0.5m
🟥	COMMERCIAL BUILDING INUNDATED BY DEPTHS >0.5m

REFERENCE NOTES:

1. AERIAL PHOTO, BUILDING OUTLINES AND PROPERTY BOUNDARIES SOURCED FROM LINZ.

50 0 100 200m

SCALE 1:5000

FOR CONSENT

REV	DATE	ISSUE	BY
1		FOR CONSENT	OBG

DESIGN: GL
DES CHECK: GL
DRAWN: OOBG
CAD CHECK: JM
APPROVED FOR ISSUE: D TATE
DATE DRAWN: AUG. 2020
ISSUE DATE: 01 / 09 / 20

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CLIENT: TE TAI TOKERAU WATER TRUST
ADDRESS: NORTHLAND
PROJECT: TE RUAOTEHAUHAU WATER STORAGE RESERVOIR
SHEET TITLE: SUNNY DAY BREACH - PEAK LEVELS (INSERT)

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SCALE (A3): 1:5000
ORIG. SHEET SIZE: A3
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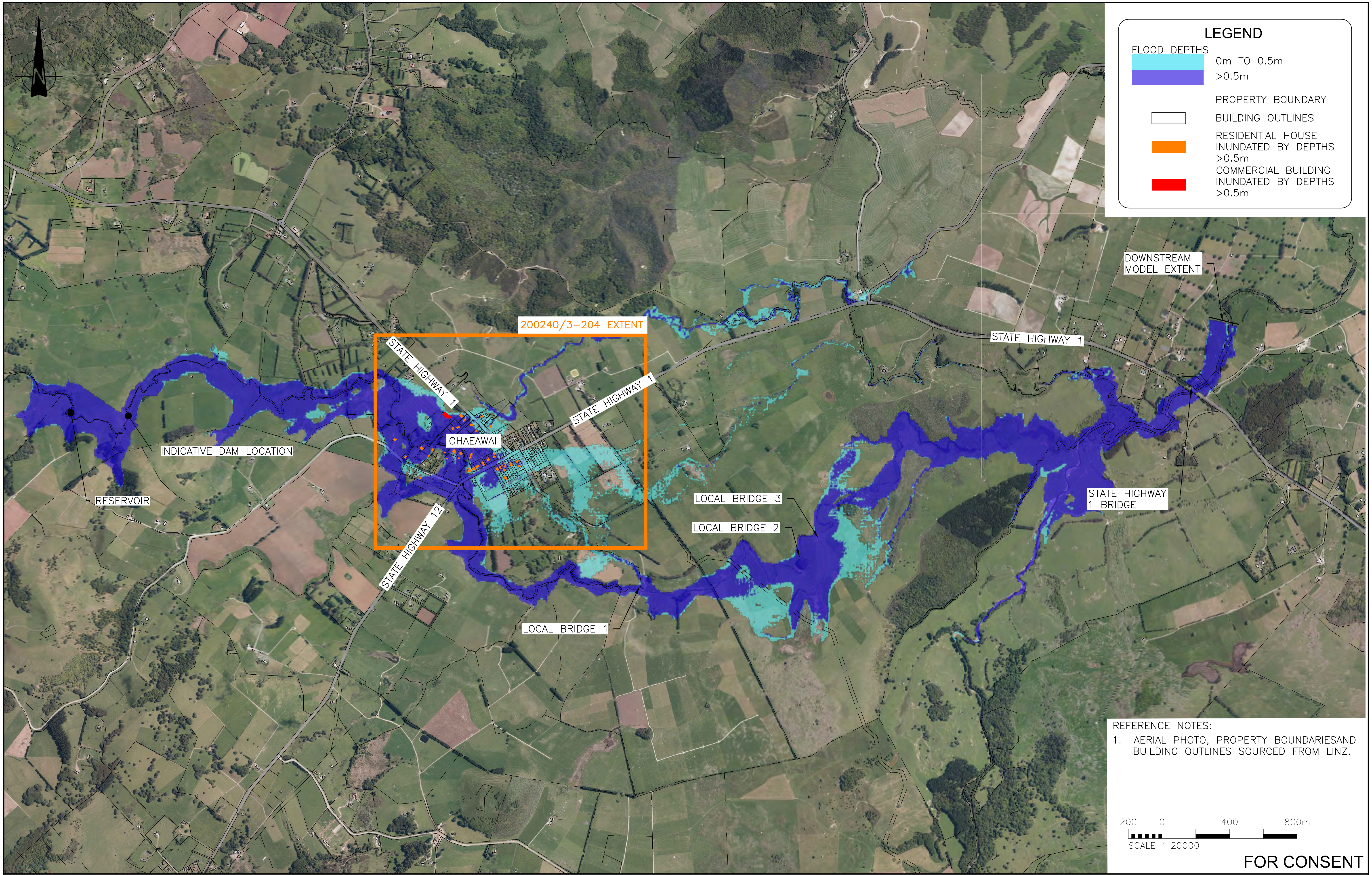
REV.: 1



LEGEND

FLOOD DEPTHS

🟦	0m TO 0.5m
🟪	>0.5m
— · —	PROPERTY BOUNDARY
☐	BUILDING OUTLINES
🟧	RESIDENTIAL HOUSE INUNDATED BY DEPTHS >0.5m
🟥	COMMERCIAL BUILDING INUNDATED BY DEPTHS >0.5m

REFERENCE NOTES:

1. AERIAL PHOTO, PROPERTY BOUNDARIESAND BUILDING OUTLINES SOURCED FROM LINZ.

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PROJECT: TE RUAOTEHAUHAU WATER STORAGE RESERVOIR
SHEET TITLE: SUNNY DAY BREACH - PEAK DEPTHS (FULL AREA)

ACENZ
ISO CERTIFIED GCS

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DRAWING No.: 200240/3-203
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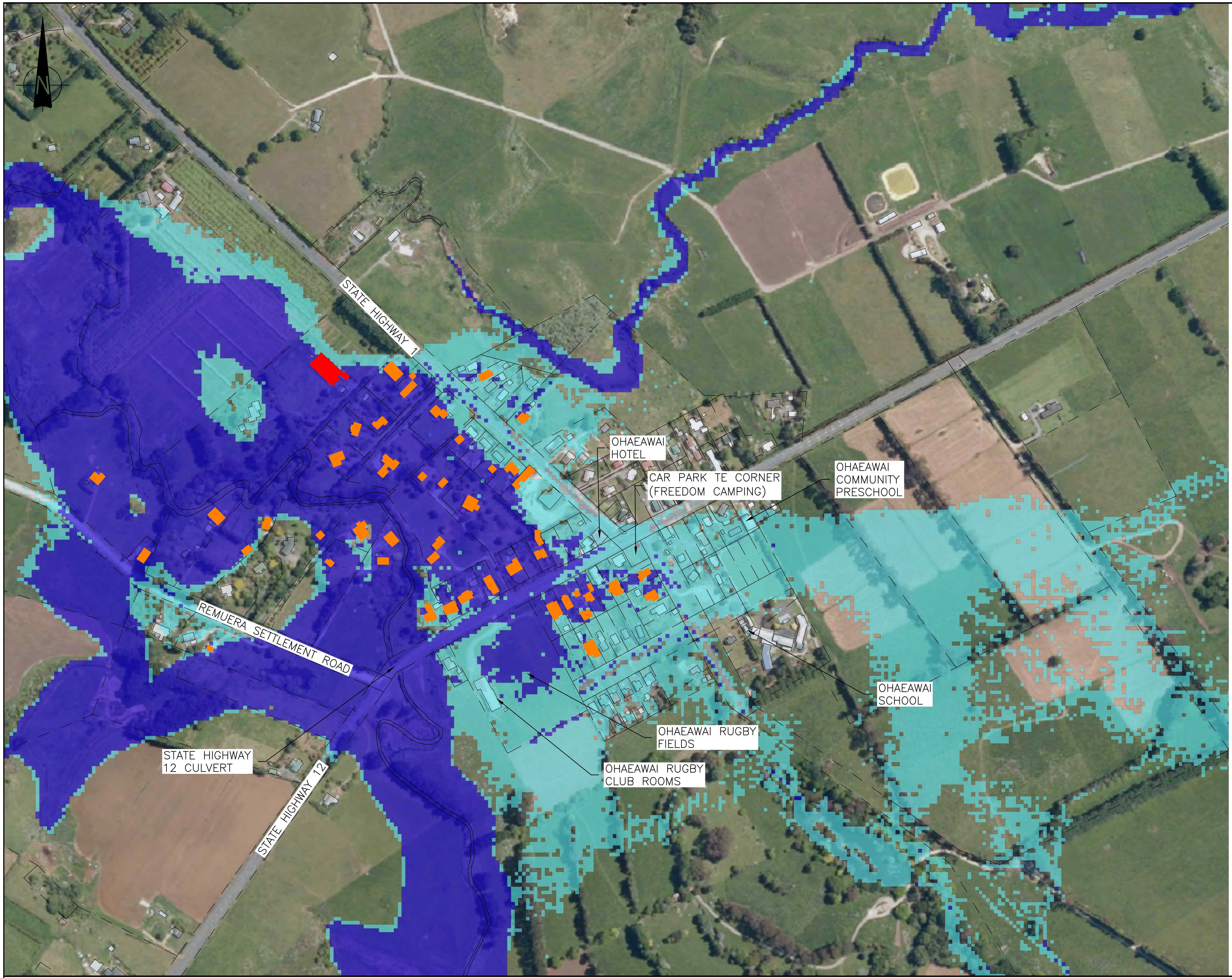

LEGEND

FLOOD DEPTHS

🟦	0m TO 0.5m
🟪	>0.5m
— · —	PROPERTY BOUNDARY
▭	BUILDING OUTLINES
🟧	RESIDENTIAL HOUSE INUNDATED BY DEPTHS >0.5m
🟥	COMMERCIAL BUILDING INUNDATED BY DEPTHS >0.5m

REFERENCE NOTES:

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50 0 100 200m

SCALE 1:5000

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SHEET TITLE	SUNNY DAY BREACH - PEAK DEPTH (INSERT)

CADFILE 200240_3-204.dwg	
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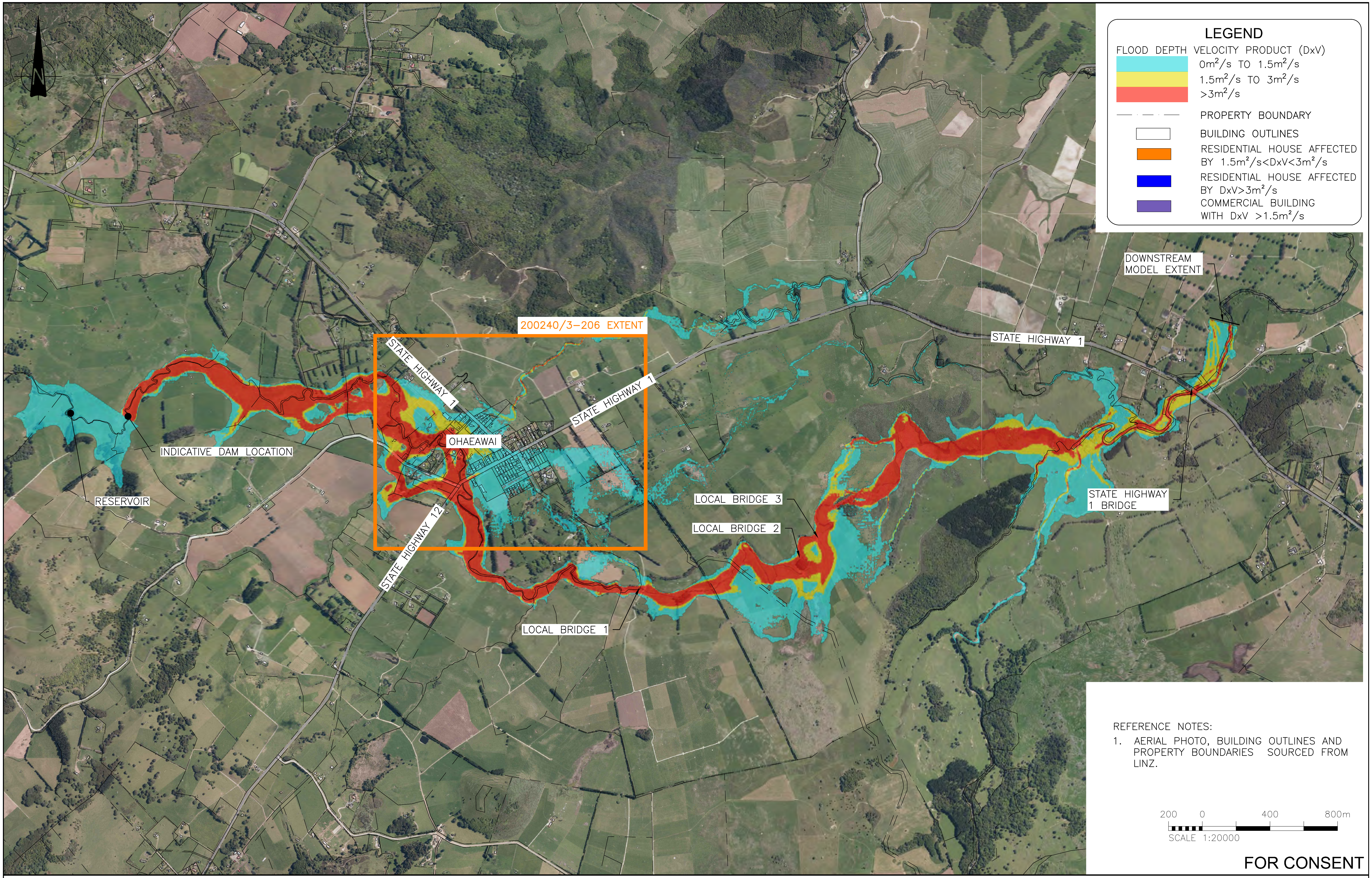

REFERENCE NOTES:

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PROJECT: TE RUAOTEHAUHAU WATER STORAGE RESERVOIR
SHEET TITLE: SUNNY DAY BREACH - PEAK DEPTH x VELOCITY (FULL AREA)

CADFILE: 200240_3–205.dwg
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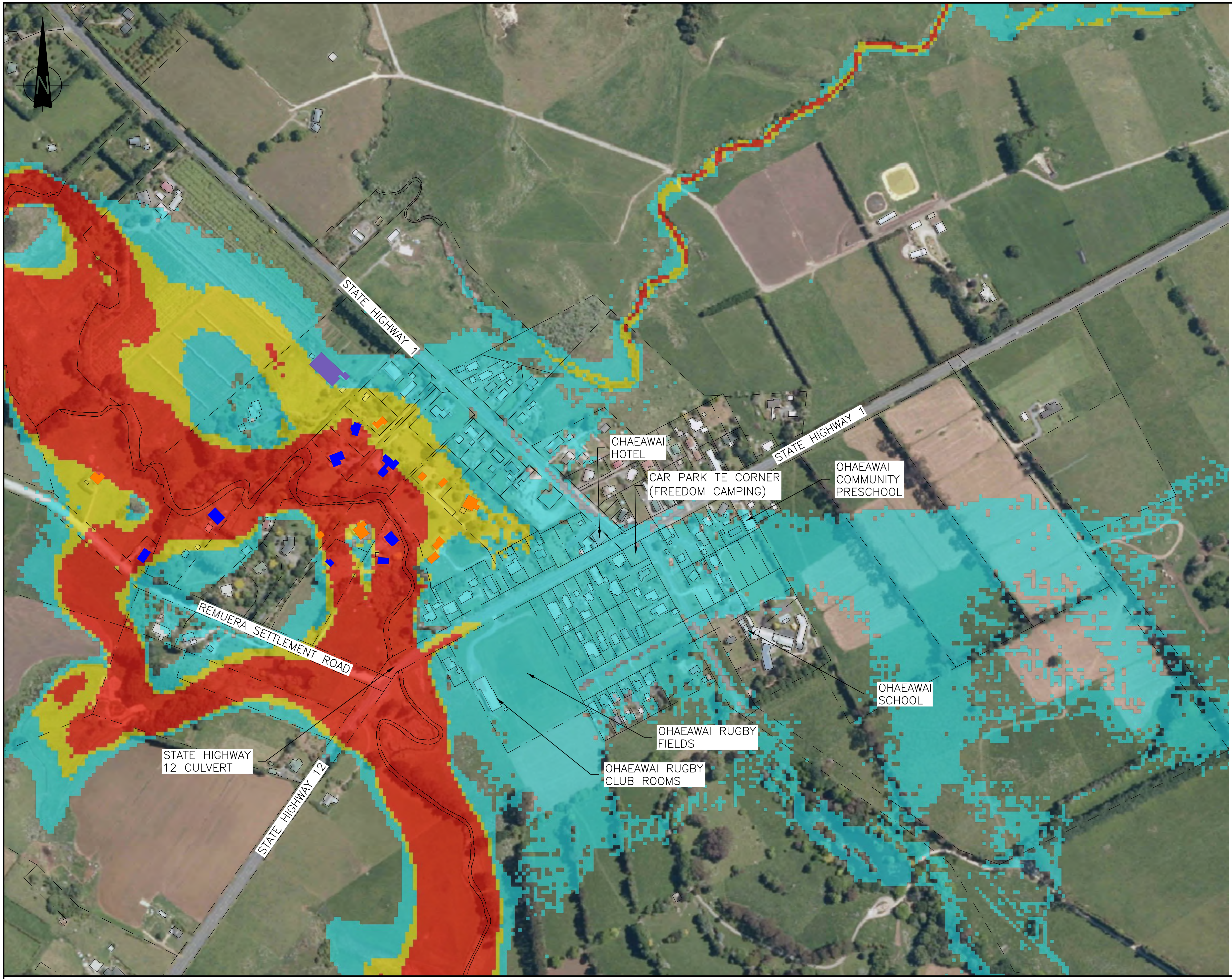
REV.: 1



LEGEND

FLOOD DEPTH VELOCITY PRODUCT (DxV)

🟦	$0m^2/s$ TO $1.5m^2/s$
🟨	$1.5m^2/s$ TO $3m^2/s$
🟥	$>3m^2/s$
— · —	PROPERTY BOUNDARY
☐	BUILDING OUTLINES
🟧	RESIDENTIAL HOUSE AFFECTED BY $1.5m^2/s<DxV<3m^2/s$
🟦	RESIDENTIAL HOUSE AFFECTED BY $DxV>3m^2/s$
🟪	COMMERCIAL BUILDING WITH DxV $>1.5m^2/s$

REFERENCE NOTES:

1. AERIAL PHOTO, BUILDING OUTLINES AND PROPERTY BOUNDARIES SOURCED FROM LINZ.

50 0 100 200m

SCALE 1:5000

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SHEET TITLE	SUNNY DAY BREACH - PEAK DEPTH x VELOCITY (INSERT)

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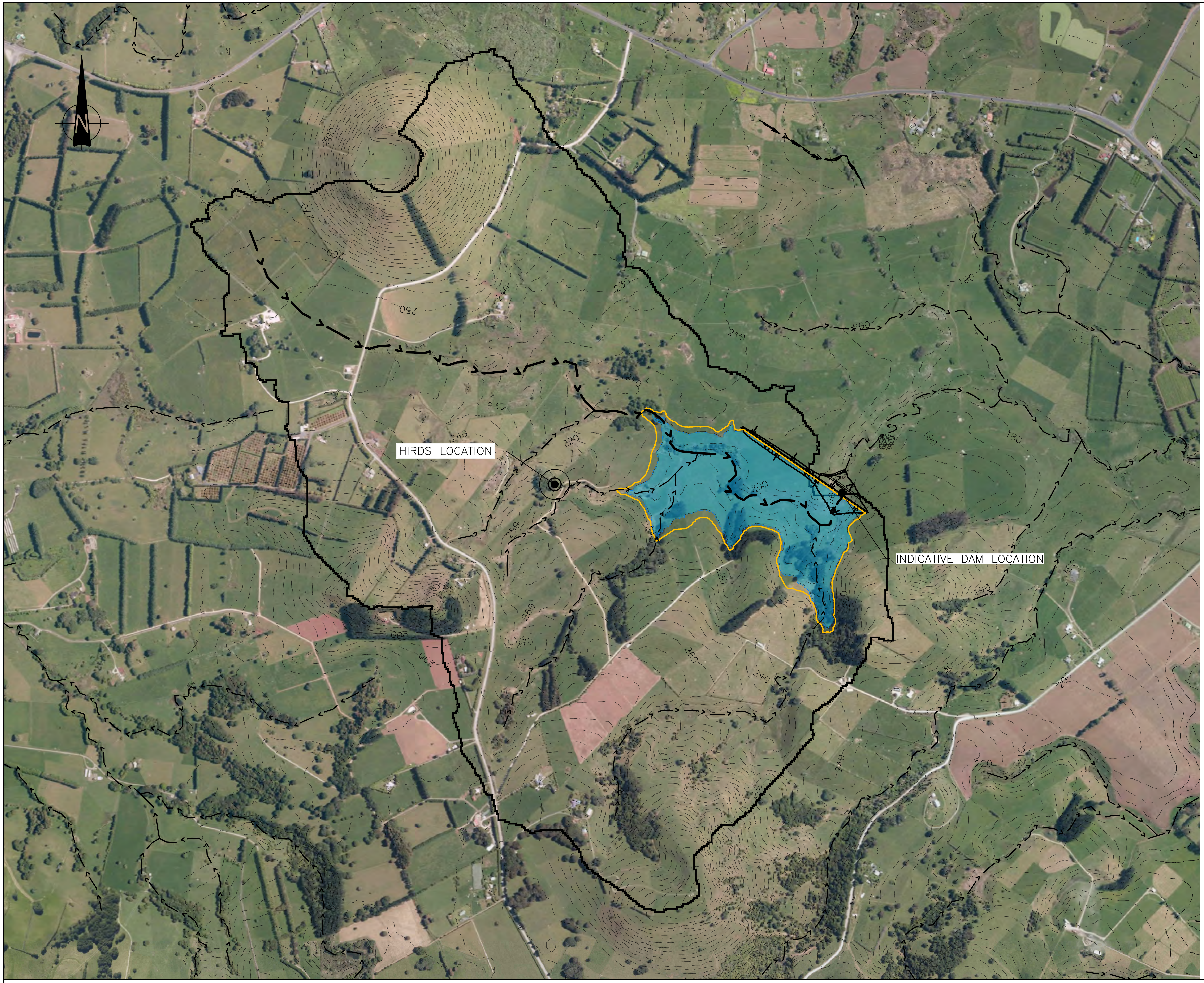

LEGEND

▬	CATCHMENT BOUNDARY
━ ➤ ━	LONGEST FLOW PATH
— › — › —	INDICATIVE WATERCOURSE
— 260 —	5m CONTOURS
🟦	INDICATIVE RESERVOIR EXTENT

REFERENCE NOTES:

1. AERIAL PHOTO SOURCED FROM LINZ (2014–2016)

SCALE 1: 12000

0 120 240 360 480 720 (m)

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PROJECT	TE RUAOTEHAUHAU WATER STORAGE RESERVOIR
SHEET TITLE	CATCHMENT PLAN - AERIAL BACKGROUND

ACENZ

ISO CERTIFIED GCS

CADFILE	
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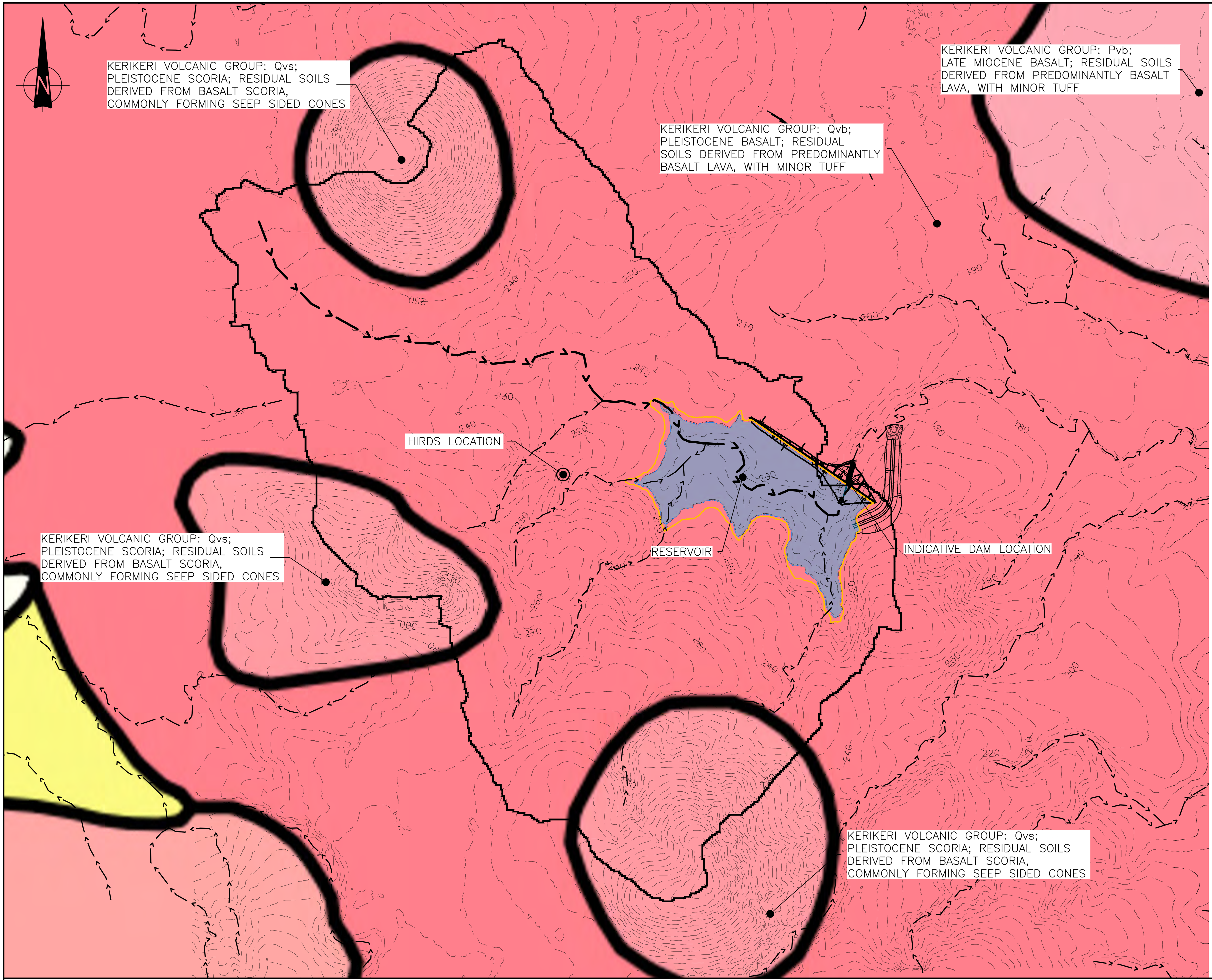

LEGEND

CATCHMENT BOUNDARY
LONGEST FLOW PATH
INDICATIVE WATERCOURSE
260 5m CONTOURS
INDICATIVE RESERVOIR EXTENT

REFERENCE NOTES:

1. GEOLOGICAL MAP SOURCED FROM GNS QMAP (2014).

SCALE 1: 12000

0 120 240 360 480 720 (m)

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SHEET TITLE CATCHMENT PLAN - GEOLOGY BACKGROUND

CADFILE 200240_3-211.dwg
SCALE (A3) 1:12000
ORIG. SHEET SIZE A3
DRAWING No. 200240/3-211
REV. 1

LEGEND

🟦	INUNDATION EXTENT
—206—	WATER LEVEL CONTOURS (1m)
+206.78	WATER LEVEL SPOT HEIGHT
– – – – – –	PROPOSED GROUND LEVEL CONTOURS (1m)
— · — · —	INDICATIVE EARTHWORKS EXTENT

REFERENCE NOTES:

1. AERIAL PHOTO SOURCED FROM LINZ.
2. GROUND CONTOURS ARE EXTRACTED FROM 2017 LIDAR AND HAVE BEEN MODIFIED WITHIN THE PROPOSED EARTHWORKS EXTENT.

20 0 40 80m

SCALE 1:2000

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SHEET TITLE PMF DESIGN FLOOD - PEAK LEVELS

CADFILE 200240_3–220.dwg
SCALE (A3) 1:2000
ORIG. SHEET SIZE A3
DRAWING No. 200240/3-220
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LEGEND

▨	0m TO 0.5m
▨	0.5m TO 1m
▨	1m TO 1.5m
▨	1.5 TO 2m
▨	>2m
- - - - - - - -	PROPOSED GROUND LEVEL CONTOURS (1m)
—·—·—	INDICATIVE EARTHWORKS EXTENT

REFERENCE NOTES:

1. AERIAL PHOTO SOURCED FROM LINZ.
2. GROUND CONTOURS ARE EXTRACTED FROM 2017 LIDAR AND HAVE BEEN MODIFIED WITHIN THE PROPOSED EARTHWORKS EXTENT.

20 0 40 80m
SCALE 1:2000

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PROJECT	TE RUAOTEHAUHAU WATER STORAGE RESERVOIR
SHEET TITLE	PMF DESIGN FLOOD - PEAK DEPTHS

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ISO CERTIFIED GCS

CADFILE	200240_3–221.dwg
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ORIG. SHEET SIZE	A3
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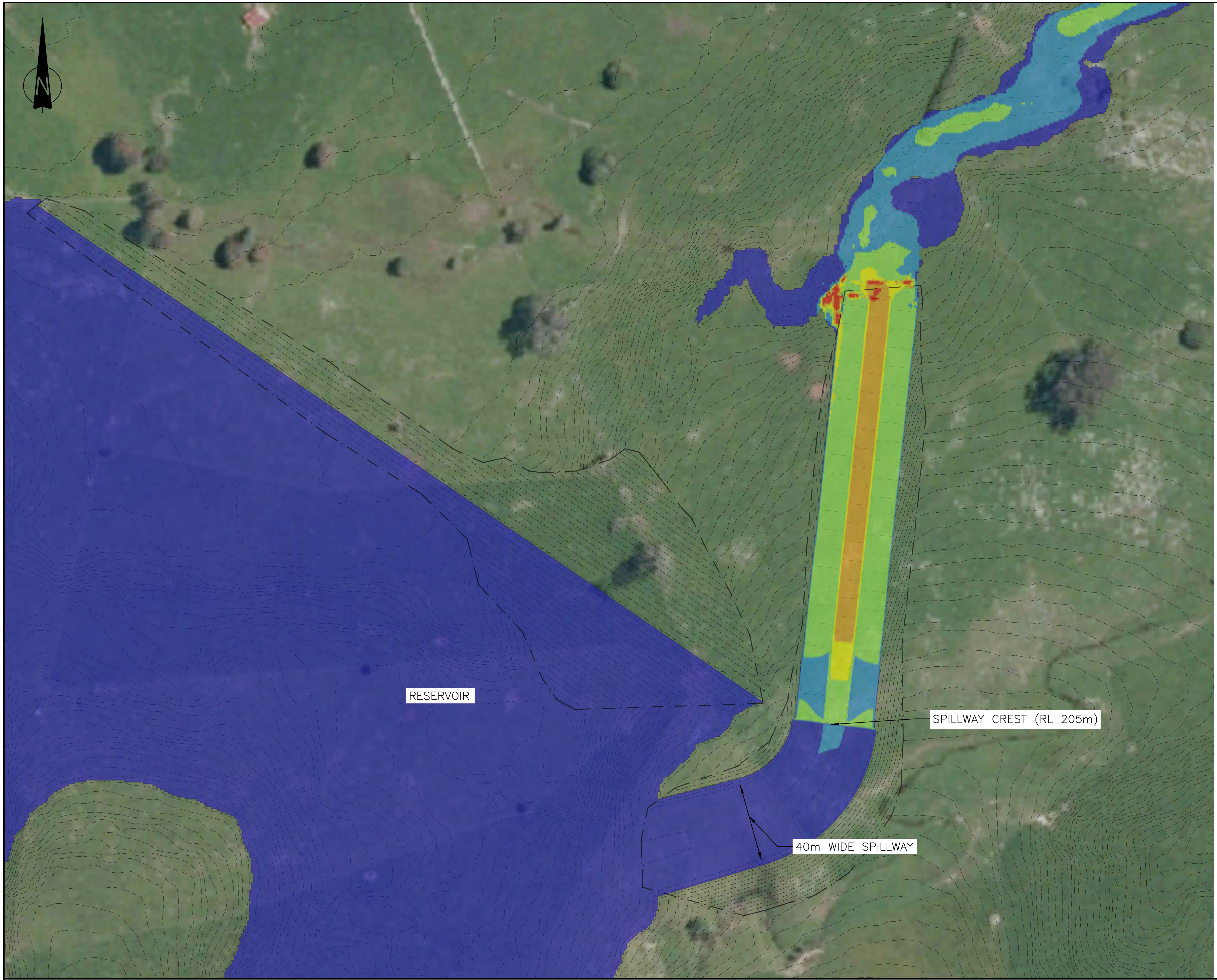

LEGEND

🟦	0m/s TO 2m/s
🟦	2m/s TO 4m/s
🟩	4m/s TO 6m/s
🟨	6m/s TO 8m/s
🟧	8m/s TO 10m/s
🟥	10m/s TO 12m/s
- - - - - - - -	PROPOSED & EXISTING GROUND LEVEL CONTOURS (1m)
—— · —— · ——	INDICATIVE EARTHWORKS EXTENT

REFERENCE NOTES:

1. AERIAL PHOTO SOURCED FROM LINZ.
2. GROUND CONTOURS ARE EXTRACTED FROM 2017 LIDAR AND HAVE BEEN MODIFIED WITHIN THE PROPOSED EARTHWORKS EXTENT.

20 0 40 80m

SCALE 1:2000

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PROJECT	TE RUAOTEHAUHAU WATER STORAGE RESERVOIR
SHEET TITLE	PMF DESIGN FLOOD - PEAK VELOCITIES

ACENZ
ISO CERTIFIED GCS

CADFILE	200240_3–222.dwg
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ORIG. SHEET SIZE	A3
DRAWING No.	200240/3-222
REV.	1

Appendix F. Ecological Assessment Report

Te Ruaotehauhau Stream Water Storage Reservoir

Preliminary Assessment of Ecological Values and Effects

1 September 2020

puhoistour.co.nz
PUHOI STOUR LIMITED
LYSAGHT BUILDING | 101 PAKENHAM
STREET AUCKLAND 1010

Te Ruaotehauhau Stream Water Storage Reservoir – Preliminary Assessment of Ecological Values and Effects

Prepared by Puhoi Stour Ltd in association with Tonkin & Taylor Ltd.

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Martin Neale.

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1. Introduction

Te Tai Tokerau Water Trust Board ('the applicant') have received provincial growth funding to provide improved water supply in Northland. Williamson Water and Land Advisory (WWLA) is leading the provision of a range of technical services to inform the project. Puhoi Stour Limited (PSL) and its subconsultant Tonkin & Taylor Limited (T+T) have collaborated to prepare this assessment of the potential ecological effects associated with a proposed water supply reservoir (Te Ruaotehauhau Stream Water Supply Reservoir) off Hariru Road, Kaikohe 0472, in the Far North.

In brief, the applicant proposes to construct a new water supply reservoir, by constructing a dam across the Te Ruaotehauhau Stream, and inundating a section of the Te Ruaotehauhau Stream and Waitaia Stream, tributaries, and surrounding land. The construction and ongoing operation of the water supply dam is anticipated to have the following effects on ecological values:

- Construction effects relating to earthworks and works within the bed of a stream or wetland.
- Direct and indirect effects on native freshwater fauna.
- Ongoing effects on native fish passage.
- Downstream effects on water quality and quantity.
- Loss of approximately 2,114 m permanent stream (~5,285 m2 streambed area) and 538 m intermittent stream (~108 m2 streambed area).
- Loss of 0.47 ha of pūriri forest;
- Loss of 0.32 ha of swamp forest.
- Loss of 0.44 ha of secondary broadleaf forest with old-growth signatures.
- Removal of 0.14 ha of tōtara treeland, native treeland, and a further 1.32 ha exotic forest comprising pine, wattle, and redwood.
- Removal of 0.75 ha volcanic boulderfield.
- Loss of 0.03 ha of rautahi wetland.
- Loss of 0.05 ha kutakuta wetland.
- Loss of 0.22 ha of wet pasture.
- Potential direct and indirect effects on terrestrial fauna, potentially including bats, birds, lizards and kauri snails.

The scope of this report is to provide an assessment of the ecological values of the site and to report on the anticipated impacts of the project. Measures to avoid, remedy or mitigate effects are proposed. Recommendations are made to further offset or compensate residual adverse effects that cannot be otherwise avoided, remedied, or mitigated.

2. Site description

The proposed Te Ruaotehauhau Stream Water Supply Reservoir site ('MN06') is located between Hariru Road and Remuera Settlement Road, in Kaikohe, in the Far North District, Northland (Figure 1). Located in the Kaikohe Ecological District (ED), the proposed reservoir is close to ecological features such as the geothermal area of Ngawha Springs (to the south) and Lake Omapere (to the west). The site is in the headwaters of Te Ruaotehauhau Stream and Waitaia Stream, which discharge into the Waiaruhe River approximately 8 km to the east of the site. The Waiaruhe River and Waitangi River, flow over the Haruru Falls before discharging to the coast in Haruru, approximately 20 km to the east. The site is dominated by orthic allophanic (LO) soils that are characteristic of North Island volcanic ash from weathering products of volcanic rocks[1].

There are no mapped areas of ecological significance in the site. However, the site is close to the following protected natural areas (Figure 2):

---

[1] Manaaki Whenua Landcare Research Soil Portal (information retrieved from https://soils-maps.landcareresearch.co.nz/ on 20/08/2020).

- Waingaruru Stream Swamp (PNAP P05/040) within 2 km to the east,
- Ngawha Bush (PNAP P05/037) within 2 km to the south,
- Remuera Settlement Road Remnants (PNAP P05/038) within 1 km to the west, and
- Bullman Road Broadleaf Remnants (PNAP P05/069), Waikuku Road Bush (PNAP P05/068), and Waimate Broadleaf Remnants (PNAP P05/067) all within 2 km to the north.

These protected natural areas comprise volcanic broadleaf forest, pūriri forest, and habitat for native fauna including kauri snail, North Island brown kiwi, kukupa, spotless crake, banded rail, and bittern.

Vegetative cover in the area (and in the site) would have historically consisted of pūriri, taraire forest (WF7.2)[2]. Much of the indigenous forest in the ED has been cleared for farming and forestry, resulting in a fragmented landscape.

The site is an operational livestock farm and current modification of the landscape is typical of agricultural land use.

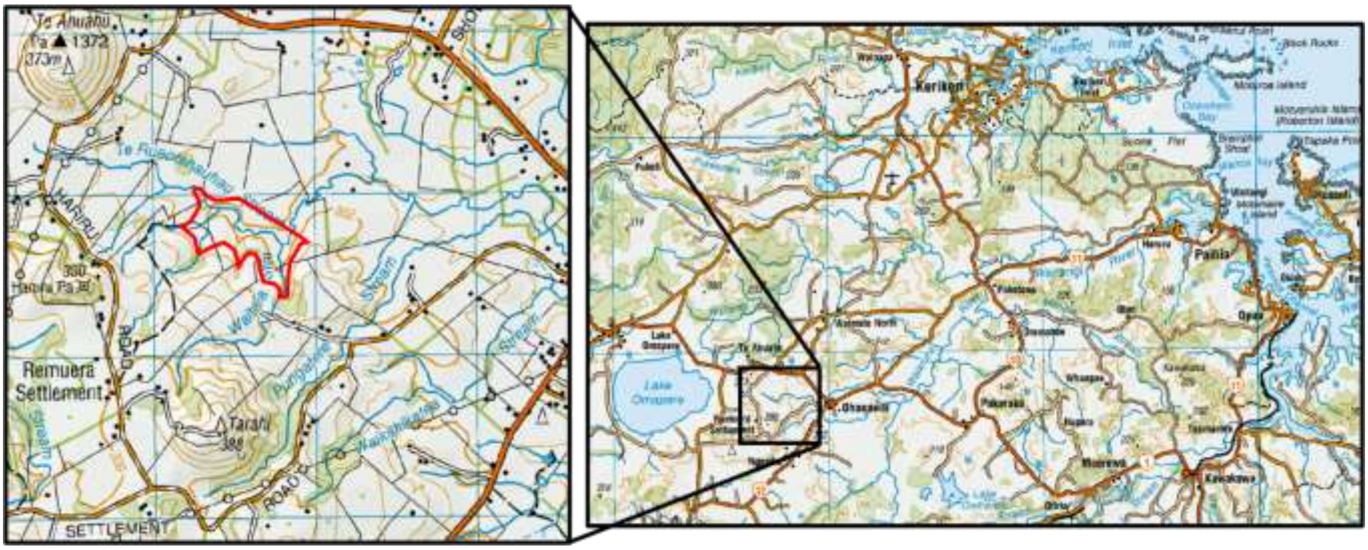

Figure 1: Location of proposed reservoir (in red outline) off Hariru Road, Kaikohe.

---

[2] Singers, N.J. D. and Rogers, G. M. (2014). A classification of New Zealand's terrestrial ecosystems. The Department of Conservation, Science for conservation 325.

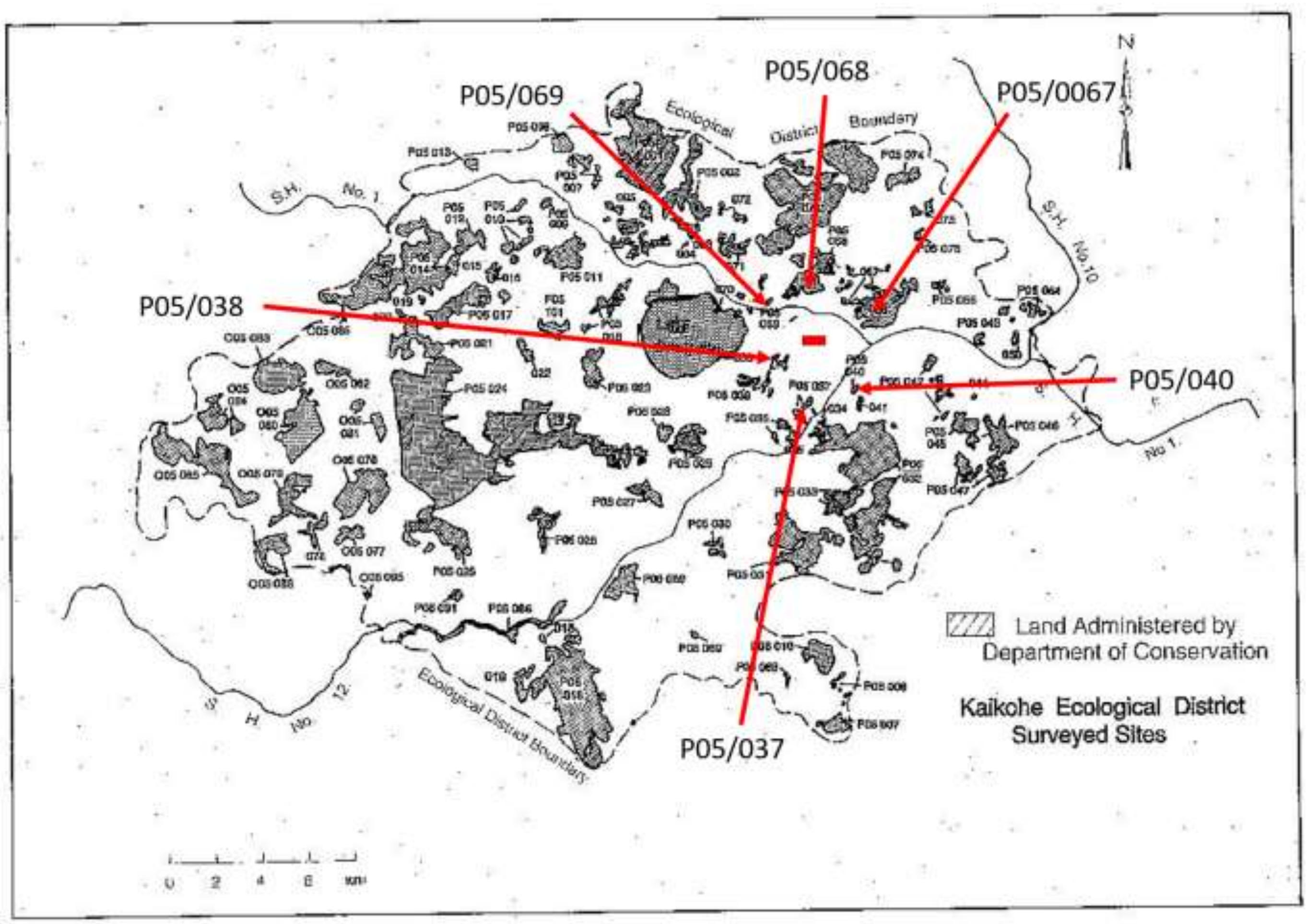

Figure 2: Location of proposed reservoir (red rectangle) in relation to nearby Protected Natural Areas in Kaikohe (modified map from the Department of Conservation).

3. Methods

A site visit to MN06 was undertaken on 15, 16 and 17 July 2020 to assess the presence of any threatened freshwater and terrestrial species and/or habitats in the proposed reservoir development. The assessment was limited to the proposed reservoir footprint and information gathered was to inform the development of an opportunity and constraints assessment report.

A follow-up site visit was scheduled for 19, 20 and 21 August 2020 to inform a more detailed assessment of ecological effects. However, due to COVID19, this site visit could not take place and so this ecological assessment of effects is based on the ecological information collected during our initial site visit and a review of desktop resources.

The details of our site assessment are included in the following sections and all sampling sites are shown in Appendix A, Figure 1.

3.1 Desktop assessment

A desktop assessment of potential freshwater and terrestrial ecological values was undertaken through a review of:

- Ecological databases including:
    - Herpetofauna Atlas;
    - Department of Conservation National bat database;

  - iNaturalist (www.iNaturalist.org);
  - eBird (www.eBird.org);
  - Kiwis for Kiwi North Island brown kiwi distribution 2016;
  - New Zealand Plant Conservation Network distribution database; and
  - New Zealand Freshwater Fish Database (NZFFD) records for Te Ruaotehauhau Stream and Waitaia Stream, and the wider Waiaruhe River catchment;
- Proposed Regional Plan for Northland, Appeals Version – June 2020;
- Northland Regional Council biodiversity online map;
- Natural areas of Kaikohe Ecological District, Reconnaissance survey report for the Protected Natural Areas Programme, dated 2000;
- Department of Conservation, a classification of New Zealand's terrestrial ecosystems, dated 2014;
- Department of Conservation (2004). Wetland Types in New Zealand.
- Manaaki Whenua Landcare Research Soil Portal;
- NIWA, New Zealand fish passage guidelines for structures less than 4m, dated 2018; and
- Other primary literature sources.

3.2 Freshwater values assessment

3.2.1 Stream classifications

During the site visit, all streams on site were classified in accordance with the definitions of intermittently/flowing river or stream set out in the Proposed Regional Plan for Northland.

Of note, heavy rain had fallen in the 48 hours prior and during the site visits. Typically stream classifications should be undertaken after 48 hours of fine weather to provide confidence that flowing water that may be present is not just related to rainfall runoff. The streams were assessed according to several criteria that define a stream or river including:

- A well-defined channel, such that the stream bed and banks are distinguishable,
- There is evidence of substrate sorting processes, including scour and deposition,
- The absence of rooted terrestrial vegetation across the cross-sectional width of the channel,
- The presence of surface water more than 48 hours after rainfall,
- Organic debris present on the floodplain as a result from flood, and
- Natural pools are present and is connected to the stream channel.

All streams within the reservoir footprint were walked to assess the presence and extent of aquatic habitat within the proposed reservoir development. These observations were recorded in ArcGIS with photographs for later analysis.

3.2.2 Macroinvertebrates

A standard macroinvertebrate (kick net) sample was collected from Te Ruaotehauhau Stream (Macro1), another sample was collected from a tributary of Te Ruaotehauhau Stream (Macro2), and the third sample was collected from Waitaia Stream (Macro3). Locations of the samples are provided in Appendix A, Figure 1.

Macroinvertebrate samples were collected in accordance with a hard-bottom semi-quantitative protocol (C1). The habitat sampled included riffles, predominantly under canopy cover. The upper layer of cobbles and large gravels were dislodged, and macroinvertebrates were collected no more than 0.5 m downstream using a D-net.

Macroinvertebrate sampling should be undertaken when the stream bed has been stable for at least one week, avoiding heavy rainfall events as to reduce the likelihood of underestimating macroinvertebrate communities. Macroinvertebrate samples were collected on 16 July, after rain had fallen on 15 July and prior heavy rain in the evening/overnight on 16 July. Abundant hard-bottom substrates were observed in the channel, indicating there was refugia for macroinvertebrates.

Macroinvertebrate identification was undertaken by EIA Limited according to the 200 Individual Fixed Count with Scan for Rare Taxa protocol (P2).

Results are presented as follows:

Taxonomic richness. This is a measure of the number of different types of macroinvertebrate present in each sample and is a reflection of the diversity of the sample;

Ephemeroptera, **Plecoptera** and **Trichoptera** ("**EPT**") richness. This index measures the number of pollution-sensitive macroinvertebrates (mayfly, stonefly, and caddisfly (excluding Oxyethira and Paroxyethira taxa because these are tolerant of degraded conditions) within a sample. Percent EPT richness represents the number of EPT taxa as a proportion of the total number of taxa within the sample;

Macroinvertebrate Community Index ("**MCI**"). The MCI is an index for assessing the quality class of a stream using presence or absence of macroinvertebrates; and

Quantitative Macroinvertebrate Community Index (**QMCI**). QMCI is another index-based tool, based on the relative abundance of taxa within a community, rather than just presence or absence.

The MCI and QMCI reflect the sensitivity of the macroinvertebrate community to changes in water quality and habitat, where higher scores indicate better stream condition. Macroinvertebrate index values are then translated to quality classes, which describe the ecological health of the stream (Table 1).

Table 1: Interpretation of macroinvertebrate biotic indices[3].

Quality class	MCI MCI-sb	QMCI QMCI-sb
Excellent	>119	> 5.99
Good	100 - 119	5.00 – 5.90
Fair	80 - 99	4.00 – 4.90
Poor	<80	< 4.00

3.2.3 Fish

Two nights of trapping was undertaken in July 2020 across the site and these locations are provided in Appendix A, Figure 1. Fish survey locations were selected based on presence of suitable stream habitat and sufficient water depth.

During the first night, un-baited gee minnow traps (GMT) (*n* = 6) and fyke nets (*n* = 1) were deployed in Te Ruaotehauhau Stream and Waitaia Stream in the footprint of the proposed reservoir.

During the second night, un-baited GMT (*n* = 7) and fyke nets (*n* = 5) were deployed in the same locations along Te Ruaotehauhau Stream and Waitaia Stream. GMT(*n* = 1) and fyke nets (*n* = 1) were also deployed in a tributary of Te Ruaotehauhau Stream.

As described above, there had been some rainfall during the week of the sampling. During the first night of trapping (15 July), the water levels dropped and some of the traps were partially exposed. Heavy rainfall on the second night of trapping (16 July) meant one trap could not be retrieved due to high flows. This trap was retrieved two days later when water levels reduced.

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[3] Stark, J D, and Maxted, J R (2007). A user guide for the macroinvertebrate community index. Prepared for the Ministry of the Environment. Cawthron Report No. 1166. 58p.

3.2.4 Stream ecological valuation

The stream ecological valuation (SEV) method[4] is typically used to evaluate the aquatic ecological function of streams by assessing physical characteristics at a reach scale, involving transects and whole of reach parameters. These data are supplemented with collected macroinvertebrate and fish data to inform 29 variables which in turn feed into 14 stream ecosystem functions. These functions fall into four broad categories as described in Table 2. The SEV method is also used to quantify the ecological impact and proposed offset measures to achieve no net loss of ecological function.

Due to COVID19 restricting site access for a second site visit, representative SEVs could not be carried out. To provide an estimate of the likely ecological function/value of the streams on site and the potential quantum of offset required, surrogate SEV scores have been calculated. These have been estimated based on site observations, site photos, and professional judgment for three representative SEVs scores within the proposed reservoir footprint. Macroinvertebrates and fish data were used for two of the SEV to inform the current values.

The selected ‘estimated’ SEV locations were representative of the streams across the reservoir footprint. Characteristics considered include stream classification, riparian margins, and streambed substrates. Therefore, two SEVs were selected in permanent reaches and one in an intermittent tributary. Of the permanent SEVs, one was selected in the main stem of Te Ruaotehauhau Stream where there was intact vegetation along at least one riparian margin (SEV 1). The other permanent SEV was located further downstream, along Te Ruaotehauhau Stream, where riparian vegetation was limited to rank grass (SEV 2). The intermittent SEV was selected for an area that was representative in that the downstream portion was dominated by rank grass and the upstream portion was under canopy (SEV 3). Other intermittent streams on site had similar characteristics. The three representative SEVs locations are provided in the Appendix A, Figure 1.

The SEV results are reported on a scale of 0 to 1, where 1 is a pristine stream (i.e. native forest, non-modified) and values below this are a departure from those reference conditions. Each function is measured and compared to what would be expected in 'reference conditions' and the final score is an aggregation of weighted attributes that identify how far from 'pristine' the stream reach is.

The SEV is a robust and internationally peer-reviewed method designed to quantify the ecological function of a stream reach. Further, when required, the method also provides a means to quantify offset requirements.

The SEV was developed for use in Auckland streams but has been successfully applied across New Zealand when local reference data has been incorporated into the SEV calculators. To our knowledge, Northland has not formally developed a SEV calculator with local reference data. For the purposes of our assessment the Auckland calculator has been used to inform the ecological values of the site.

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[4] Storey, R G, Neale, M W, Rowe, D K, Collier, K J, Hatton, C, Joy, M K, Maxted, J R, Moore, S, Parkyn, S M, Phillips, N and Quinn, J M (2011). Stream Ecological Valuation (SEV): a method for assessing the ecological function of Auckland streams. Auckland Council Technical Report 2011/009.
Neale M W, Storey R G, Rowe D K, Collier K J, Hatton C, Joy M K, Parkyn S M, Maxted J R, Moore S, Phillips N and Quinn J M (2011). Stream Ecological Valuation (SEV): A User’s Guide. Auckland Council Guideline Document 2011/001.
Neale, M W., Storey, R G and Quinn, J L (2016). Stream Ecological Valuation: application to intermittent streams. Prepared by Golder Associates (NZ) Limited for Auckland Council. Auckland Council technical report, TR2016/023.

Table 2: Stream Ecological Value (SEV) functions

SEV Functions
Hydraulic Functions
› Natural flow regime
› Floodplain effectiveness
› Connectivity for natural species migrations
› Natural connectivity to groundwater
Biogeochemical Functions
› Water temperature control
› Dissolved oxygen levels
› Organic matter input
› Instream particle retention
› Decontamination of pollutants
Habitat Provision Functions
› Fish spawning habitat
› Habitat for aquatic fauna
Biodiversity Provision Functions
› Fish fauna intact
› Invertebrate fauna intact
› Riparian vegetation intact

3.3 Terrestrial values assessment

3.3.1 Ecosystem types

A site walkover was undertaken on 15, 16 and 17 July 2020 to survey and describe terrestrial ecological values across the Project footprint.

The field assessment included mapping all terrestrial and wetland ecosystems, developing a vascular plant species list, and undertaking targeted searches for key At Risk and Threatened species according to the current threat rankings published by DOC[5]. Terrestrial and wetland ecosystems were assessed and classified according to Singers & Rogers (2014)[6] where the habitat remained intact, and in accordance with the Proposed Regional Plan definitions[7] and criteria set out in Appendix 5 of the Regional Policy Statement for Northland.

Offsetting of impacted ecosystem types has been estimated using previously constructed models in similar habitat types to arrive at an estimated offset quantum that will be required. The actual offsetting will be determined following discussions with the local community and after further field surveys have been undertaken.

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[5] Department of Conservation (n.d.).New Zealand Threat Classification Series. Accessed on 28 July 2020 from https://www.doc.govt.nz/about-us/science-publications/series/new-zealand-threat-classification-series/

[6] Singers, N. J., & Rogers, G. M. (2014). *A classification of New Zealand's terrestrial ecosystems*. Department of Conservation.

[7] The definitions relating to wetlands are currently under appeal, however considered appropriate for this assessment.

3.3.2 Bats

The Project footprint is situated approximately 16 km from known long-tailed (*Chalinolobus tuberculatus*) and northern lesser short-tailed (*Mystacina tuberculata aupourica*) bat populations at Puketi Forest[8], and within 4 km of long-tailed bat records identified as part of the Matawii Reservoir Assessment of Ecological Effects[9].

Long-tailed bats ('Threatened – Nationally Critical'[10]) are an edge-adapted species and utilise a variety of ecosystems for foraging and roosting including forest edges, hedgerows and shelterbelts. Long-tailed bats are frequently identified utilising fragments of native and exotic forest for foraging and roosting.

Northern lesser short-tailed bat (Threatened – Nationally Vulnerable) are adapted to mature forest interior habitat and tend to remain within contiguous mature native forest, however given the close proximity of Puketi Forest it is possible that short-tailed bats may be present at the site.

Potential bat foraging, commuting and roosting habitat was assessed across the proposed footprint. Potential bat roost habitat comprised trees greater than 15 cm diameter at breast height (DBH) and with any of the following characteristics:

- Cavities, cracks and crevices;
- Epiphytes, particularly large perching epiphytes; and/or
- Flaky and peeling bark.

Acoustic survey using Automated Bat Monitors (ABMs) would ordinarily be undertaken in order to detect the presence of bats on site. However acoustic survey should only be undertaken during warmer months (October to April inclusive) when bats are more mobile. The site visit took place outside this period, and therefore an acoustic survey was not undertaken.

3.3.3 Birds

To assess avifauna composition across the site, all incidental bird observations (seen or heard) were recorded during the site visit.

North Island brown kiwi (*Apteryx mantelli*) have been recorded at a high density in close proximity to the Project footprint, as determined through a review of Northland kiwi distributions[11] and are conservatively assumed to be present until kiwi surveys are undertaken to determine actual presence or absence across the site. North Island brown kiwi in Northland are known to utilise existing fragmented habitat as foraging and roosting stepping stones across the landscape.

North Island brown kiwi habitat was identified as having any of the following characteristics:

- Indigenous forest and scrub; and
- Exotic forest and scrub.
-

3.3.4 Herpetofauna

Potential herpetofauna (gecko and skink) habitat was identified as having any of the following potential lizard characteristics:

- Rank grass;
- Coarse woody debris;
- Deep leaf litter;
- Boulders and rocks;

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[8] Sourced from Department of Conservation National Bat Database

[9] Puhoi Stour & Tonkin and Taylor Ltd. (2020). Kopenui Stream Reservoir Assessment of Ecological Effects. Prepared for Northland Regional Council. PSL Report Number 2020/02.

[10] O'Donnell, C.F.J., Borkin, K.M., Christie, J.E., Lloyd, B., Parsons, S. & Hitchmough, R.A. 2018: Conservation status of New Zealand bats, 2017. *New Zealand Threat Classification Series 21*. Department of Conservation, Wellington, New Zealand. 4 pp.

[11] Kiwis for Kiwi (2016). North Island Brown Kiwi Estimated distribution 2016.

- Exotic vegetation, such as *Tradescantia* ground cover; and
- Native vegetation (including mature forest and secondary successional vegetation).

Due to the site visit being undertaken during winter, spotlighting for geckos and manual searching for skinks was not undertaken. Lizard searches are best undertaken between October and April (inclusive).

3.3.5 Invertebrates

Potential kauri snail (*Paryphanta* spp.) habitat was assessed by identifying potential areas of deep leaf litter, fern skirts and logs, particularly where indigenous forest is present.

3.4 Assessment of effects

The method applied to this assessment of ecological effects broadly follows the Ecological Impact Assessment Guidelines (EcIAG) published by the Environment Institute of Australia and New Zealand (EIANZ)[12].Using a standard framework and matrix approach such as this provides a consistent and transparent assessment of effects.

Outlined in the following sections, the guidelines have been used to inform the following:

- The level of ecological value of the environment based on the information available;
- The magnitude of ecological effect from the proposed water supply reservoir on the environment;
- The overall level of effect to determine if further measure to address effects are required; and,
- The magnitude of effect and overall level of effect, taking into consideration the additional measures to avoid, remedy or mitigate effects and whether there are residual adverse effects that should be offset or compensated (s 104(ab) RMA).

Consideration was also given to Policy D.2.16 of the Proposed Regional Plan for Northland (Appeals Version June 2020) regarding managing adverse effects on indigenous biodiversity. Criteria set out in Appendix 5 of the Regional Policy Statement for Northland (updated 2018) were used in the assessments of ecological significance.

The framework for assessment provides structure to quantify the level of ecological effects but needs to incorporate sound ecological judgement to be meaningful. Deviations or adaptions from the methodology are identified within each of the following sections as appropriate. Further detail regarding these guidelines is included in Appendix B.

4. Freshwater ecological assessment

4.1 Freshwater values

4.1.1 Stream classification and values

The site is in the Te Ruaotehauhau Stream and Waitaia Stream catchment. Streams had natural channels, had hard-bottom substrates, and were either shaded under remnant native vegetation and exotic treelands or open channels along paddock margins.

Te Ruaotehauhau Stream and Waitaia Stream are both classified as continuously flowing permanent streams. Te Ruaotehauhau Stream is located along the centre of the proposed reservoir. Waitaia Stream forms the eastern arm of the proposed reservoir. Several tributaries of Te Ruaotehauhau Stream and Waitaia Stream are present throughout the site which have also been classified as permanent (labelled and shown in Appendix A, Figure 1). Several of the upper reaches of narrow

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[12] Roper-Lindsay, J., Fuller, S.A., Hooson, S., Sanders, M.D., and Ussher, G.T. (2018). Ecological Impact Assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition.

tributaries of Te Ruaotehauhau Stream have been classified as intermittent due to shallow water depth and the likelihood of becoming periodically dry over summer.

The Te Ruaotehauhau Stream is approximately on average 2.5 m wide with an approximate average depth of 0.5 m. The Waitaia Stream is approximately on average 1.5 m wide with an approximate average depth of 0.4 m. The average widths observed on site are bank full widths rather than 'normal' wetted widths, due to the rain that fell prior to and during the site visit. Aquatic habitat was diverse and included gravel, cobbles, bedrock across all streams, and woody debris, and root mats under canopy cover. Instream hydrological heterogeneity was also diverse comprising riffles, small cascades, runs, and pools with a variety of sizes and depths. Fine sediment deposition was observed in isolated sections of the main channels of Te Ruaotehauhau Stream and Waitaia Stream. Tributary 1A, 2, and smaller intermittent streams had relatively high fine sediment loading on the streambed.

Roughly half the streams (permanent and intermittent) on site had riparian vegetation either on both banks or on one bank. Riparian vegetation comprised an intermix of native forest, advanced secondary broadleaf forest, native treelands, and exotic treelands.

Where sections of the streams lacked intact riparian vegetation, the margin was limited to rank grass. These sections of stream had 'very low' to 'no effective' shading. Most of the streams on site were fenced from livestock access. Fences (barbed wire and hot-wire) were generally intact and well-maintained.

Submerged and surface reaching macrophytes were absent in most streams across site, including open channels. Macrophytes only appeared in small clusters along the upper sections of Waitaia Stream where the pine vegetation had recently been felled and along intermittent streams such as Tributary 2.

Based on site observations and site photos, the estimated current stream ecological valuations for representative streams within the proposed reservoir footprint are presented in Table 3.

Te Ruaotehauhau Stream and Waitaia Stream have similar characteristics and are both permanent streams, therefore the estimated SEV for the main stem of the Te Ruaotehauhau Stream is considered representative for the main stem of the Waitaia Stream. Two representative SEV were estimated for these streams, being one with (SEV1) and one without (SEV2) intact canopy cover. Other permanent streams such as Trib1, 1A, 3, and 4 also have similar characteristics to that of Te Ruaotehauhau Stream, therefore these SEV are considered representative.

Tributary 2 of Te Ruaotehauhau Stream is a shaded intermittent stream and is representative of other small intermittent tributaries of Te Ruaotehauhau Stream and Waitaia Stream. SEV3 is considered representative of all intermittent streams.

The fish fauna intact (FFI) and invertebrate fauna intact (IFI) function in the SEV was included for the estimated SEVi-C for SEV1 and SEV2. Fish observations and macroinvertebrate surveys were carried out along the main stem of Te Ruaotehauhau Stream, and so were considered representative.

Fish observations and macroinvertebrate surveys were not carried out in Tributary 2, therefore FFI and IFI functions were not included in the estimated SEV3 score.

Photographs of each of the representative SEV areas are provided in Appendix C.

Table 3: Estimated SEV values for three representative streams within the proposed reservoir footprint.

SEV ID	**SEV1**	**SEV2**	**SEV3**
Location	Te Ruaotehauhau Stream (under riparian canopy)	Te Ruaotehauhau Stream (open channel)	Tributary2
Classification	Permanent	Permanent	Intermittent
SEVi-C	0.75 (incl IFFI, FFI)	0.46 (incl IFFI, FFI)	0.61 (excl IFI, FFI)

A desktop review of the downstream environment outside of the reservoir was undertaken. The downstream environment appears to be similar to the main stem of Te Ruaotehauhau Stream in the footprint. Of note, the riparian margin downstream of the proposed reservoir is limited to rank or grazed grass. It is assumed that the instream substrates are similar to that observed in the most downstream portion of Te Ruaotehauhau Stream on site, consisting of hard-bottom substrates ranging from gravels to cobbles.

4.1.2 Macroinvertebrates

Three kick samples were collected across site, one in the Te Ruaotehauhau Stream, one in a tributary of the Te Ruaotehauhau Stream (Tributary 1), and one in Waitaia Stream.

Twenty-nine invertebrate taxa were recorded from Te Ruaotehauhau Stream. The invertebrate community indicates a ‘good’ quality class with a MCI value of 101 and a QMCI value of 5.7. Sensitive EPT taxa made up 41% of the individuals within the sample. Of note, *Hydrobiosella*, an uncased caddisfly with very low tolerance to polluted water (MCI score of 9) was relatively abundant (10%) in the sample.

Twenty-six invertebrate taxa were recorded from Tributary 1 (a tributary of the Te Ruaotehauhau Stream). The invertebrate community sample indicates ‘good’ and ‘excellent’ water and habitat quality, with a MCI value of 113 and QMCI value of 7.3. Sensitive EPT taxa made up 84% of the individuals within the sample. Of note, *Coloburiscus*, a mayfly with very low tolerance to polluted water (MCI score of 9) and *Zephlebia* (MCI score of 7) collectively dominated (65%) the sample.

The sample from Waitaia Stream had a similar number of taxa, and ‘good’ MCI and QMCI values. Compared to the other samples, the Waitaia Stream sample had a notably lower proportion of EPT taxa, being only 12%. Instead, the sample was dominated by Potamopyrgus, a relatively tolerant freshwater snail, comprising 60% of the individuals within the sample.

The summary statistics for the samples collected in this survey are provided in Table 4, with full taxa list provided in Appendix D.

Table 4: Summary statistics for macroinvertebrates collected from Te Ruaotehauhau Stream, Trib 1, and Waitaia Stream, in the proposed MN06 reservoir footprint (July 2020).

Site name	Taxa richness	EPT richness	Number of individuals	MCI value	MCI class	QMCI value	QMCI class
Te Ruaotehauhau Stream	29	7	182	101.4	Good	5.7	Good
Tributary 1	26	11	200	113.8	Good	7.3	Excellent
Waitaia Stream	24	9	121	112.5	Good	4.6	Good

4.1.3 Freshwater fauna

During the first night of the fish survey, five kēwai (*Paranephrops planifrons*) were recorded from the Waitaia Stream and two kēwai were recorded from the Te Ruaotehauhau Stream.

During the second night of the fish survey, three longfin eels (*Anguilla dieffenbachii*) (At Risk - Declining) ranging in size from 600 mm to 700 mm were recorded from three separate fyke nets; one in each of the Te Ruaotehauhau Stream, Trib 1, and Waitaia Stream. Two elver were recorded in the downstream portion of the Te Ruaotehauhau Stream. Three common bullies (*Gobiomorphus cotidianus*) ranging in size from 40 mm to 60 mm were recorded; one was caught in a GMT from the downstream extent of the Te Ruaotehauhau Stream, and two were caught in the same fyke net from the Waitaia Stream.

A summary table of the freshwater fauna caught in this survey is provided in Table 5.

A desktop review, using the NZFFD, of streams in the Te Ruaotehauhau catchment and the wider Waiaruhe River catchment was carried out. In addition to the fish species caught during our fish survey, a diverse range of fish species have been recorded downstream and outside the proposed reservoir footprint in the wider catchment. Native fish species include banded kōkopu (*Galaxias fasciatus*), Cran's bullies (*Gobiomorphus cotidianus*), shortfin eels (*Anguilla australis*), and black mudfish (*Neochanna diver*sus) (At Risk - Declining). Additionally, exotic and pest fish species recorded include gambusia (*Gambusia affinis*), rudd (*Scardinius erythrophthalmus*), and tench (*Tinca tinca*). Some of these fish species (native and exotic) may use the stream network on site. However, black mudfish are unlikely to be present on site because they inhabit wetland stream systems and the streams on site are not associated with wetlands.

The presence of longfin eel, an At Risk – Declining species, at the site meets the 'rarity/distinctiveness' criteria within Appendix 5 of the Regional Policy Statement for Northland. Therefore, the stream channels are classified as 'significant habitats of indigenous fauna'.

Table 5: Freshwater fauna recorded within the proposed MN06 reservoir footprint, survey methods, and threat statutes (including sampling undertaken in July 2020).

Common name	Scientific name	Gee-minnow (GMT)	Fyke net	Threat status[10, 13]	Ecological value[14]
Tuna/longfin eel	*Anguilla dieffenbachii*	-	3	At Risk - Declining	High
Common bully	*Gobiomorphus cotidianus*	1	2	Not threatened	Moderate
Elver	-	1	1	-	-
Kēwai/freshwater cray	*Paranephrops planifrons*	13	4	Not threatened	Moderate

4.1.4 Summary of freshwater ecology values

Stream ecological valuations for representative stream reaches across the site have been estimated based on site walkover observations and photos. Based on the combination of stream characteristics, macroinvertebrate communities, and fish communities, we estimate that the stream ecological values for both intermittent and permanent streams to be between **high** and **very high**. It is recommended that representative SEVs be carried out to assess and confirm the current ecological values.

4.2 Assessment of ecological effects - freshwater

4.2.1 Sedimentation during construction

Works within and adjacent to the bed of wetlands and streams ('streamworks') can result in an uncontrolled discharge of sediment laden water during construction.

The effect of excess in-stream sedimentation is recognised as a major impact of changing land use on river and stream health, through changes in water clarity and sediment deposition dynamics. Sediment entering stream systems can impact water clarity through sediment suspended within the water column ('suspended sediments'). Many native species (including longfin eels) are tolerant of elevated suspended sediment, measured either by turbid water or high concentrations of total suspended solids ("TSS")[15].

Sedimentation can also have noticeable effects on physical habitat in streams when it is deposited on the streambed ('deposited sediments'). Excess deposited sediment can clog the small spaces (interstitial) between hard stream substrates which impacts aquatic macroinvertebrates, alters food sources (i.e. macroinvertebrates for predation by fish), and removes egg-laying sites for native freshwater fauna.

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[13] Dunn, N. R., Allibone, R. M., Closs, G. P., Crow, S. K., David, B. O., Goodman, J. M., Griffiths, M., Jack, D. C., Ling, N., Waters, J. M., and Rolfe, J. R. (2017). *Conservation status of New Zealand freshwater fishes*. Department of Conservation.

[14] Roper-Lindsay, J., Fuller, S., Hooson, S., & Sanders, M. (2018). Ecological impact assessment guidelines for New Zealand, 2nd Edition. Environment Institute of Australia and New Zealand Inc.

[15] For summary of research see Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, C.D., Quinn, J.M. and Death, R.G. (2011) Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. Cawthron Institute, Nelson, New Zealand.

The presence of sensitive macroinvertebrate community taxa (mayflies and caddisflies) in the streams on site indicate healthy water quality and habitat. Kēwai were also found within streams throughout the site, which are typically found in healthy streams. No anaerobic sediments were observed during the site visit and the water column had good clarity throughout the site, even after heavy rainfall and at the most downstream section of Te Ruaotehauhau where the channel is open and lacking riparian cover. Therefore, it is recommended that any streamworks are undertaken during earthworks season when there is less flow and potential effects are expected to be easier to manage. It is recommended that the streamworks specific provisions are incorporated into the sediment and erosion controls for the site in accordance with best practice recommendations. We recommend using Auckland Council Guidance Document 5 (GD05).

The streamworks methodology for dewatering, mucking out, and diversion of clean/dirty water has not yet been prepared and therefore, is not included in this assessment. Given that the construction of the reservoir will result in complete and irreversible loss of stream habitat, there are likely to be opportunities to utilise in-line treatment (e.g. sediment traps) that wouldn't normally be in accordance with best practice because they would impact significantly on stream habitat. We recommend those opportunities be considered in the development of the construction methodology.

At the time of writing we do not have any detail pertaining to the construction methodology or staging. Subject to the implementation of best practice methodologies, there are no known site constraints or characteristics that suggest that the short-term effects of sedimentation associated with instream works could not be appropriately mitigated.

The stream habitat is considered to have between **high** to **very high** ecological value due to the macroinvertebrate and freshwater fauna present (including longfin eel which are classified as At Risk – Declining) and potential to support a more diverse range of freshwater fauna. The magnitude of effects of associated with construction of the reservoir was assessed as potentially **high** without sediment management, therefore giving an overall level of effects of **very high**. With the appropriate construction and sediment and erosion control methodologies to mitigate sediment and erosion control effects, the magnitude of effects could be reduced to **low**, and so the overall level of effects could be reduced to a **low** level.

4.2.2 Injury or mortality of freshwater fauna

Construction of the proposed reservoir could cause injury or mortality to native freshwater fauna during works in streams and wetlands. The magnitude of potential effect on native freshwater fauna is driven by the nature of the activity, the area of stream disturbance, density of fish present in each area, the ability of fish to escape disturbance and the controls applied. The conservation status of fish species is also relevant when assessing the potential overall level of effect.

The full construction method is unknown at this stage, but it is anticipated that the streams and wetland will require mechanical modification to form the reservoir basin. The potential impact of these works on stranding, injury and mortality can be minimised by implementing appropriate freshwater fauna salvage methods prior to works commencing. Some sections of the streams to be inundated may not be subject to physical streamworks and in those instances fish may be able to move upstream without salvage. Provided the reservoir is not filled too rapidly we expect fauna within the site to find suitable habitat unaided but should be considered further in the Freshwater Fauna Relocation Plan (FFRP). Eels and common bullies are also known to inhabit lakes. Land-locked common bully populations are known to inhabit lakes where they have been blocked off from sea due to natural processes. The creation of a reservoir is likely to result in an increase of aquatic habitat for eels, common bullies, and kēwai provided passage is maintained.

We recommend a Freshwater Fauna Relocation Plan (FFRP) is prepared as part of the reservoir construction methodology to minimise potential injury or mortality during streamworks and reservoir filling.

Longfin eel are classified as At Risk – Declining and so the freshwater fauna potentially affected by the activity is considered to have a **high** ecological value. The potential magnitude of effects of freshwater fauna stranding, injury, or mortality are assessed as **high**. Therefore, the overall level of effects would be **very high** in the absence of controls. With appropriate salvage and relocation methodologies detailed in a FFRP to minimise effects on fish during construction and reservoir filling, the magnitude of effects could be reduced to **low** and the overall level of effects to **low**.

4.2.3 Fish passage

Many of New Zealand's native fish are diadromous, meaning they migrate to and from the sea as part of their lifecycle. Artificial structures and poor culvert design can restrict fish migration. Often this occurs as a result of culverts being perched, too steep or long, subsequent increases in water flow or a resultant laminar flow with insufficient roughness to allow effective fish movement[16]. Placement of dam structures on streams and rivers can also restrict fish movement unless particular provision is made for them to pass. In addition, temporary restrictions to fish passage during construction may impact a population's reproductive success. The resultant decrease in fish mobility can cause fragmented populations, a reduction in population size, and limit overall available habitat for freshwater fauna. However, the fish community at this location is likely to be affected by the presence of Haruru Falls downstream, which will provide a migration barrier for some species of fish.

Common bullies, longfin eels, kēwai are present in the stream network on site. Common bullies can be either diadromous or non-diadromous. When considering their ability to pass barriers, common bullies are classified as swimmers[17]. This means that they usually swim around obstacles (rather than climb) and rely on areas of low velocity to rest and will exhibit intermittent burst activities to surpass high velocity areas. However, they will be mostly unaffected by the construction of the dam as they can form land-locked populations such as those in some of the Auckland water supply reservoirs[18]. Given that Haruru Falls is located downstream, the common bullies observed on site are likely to be land-locked populations. Eels are catadromous in that they live in freshwater but migrate to sea (or estuarine waters) to spawn, with juveniles returning to freshwater. Longfin eels are accomplished climbers and are well adapted to negotiating barriers to reach catchment headwaters. Kēwai are non-migratory species. They typically inhabit headwater streams but are also known to live in lakes and ponds. They prefer streams with native vegetation margins, hard-bottom substrates, and slow flowing water with areas of shallow pools[19]. Other native fish species recorded further downstream in the wider catchment may also inhabit the stream network on site. These other native fish species (such as banded kokopu and shortfin eels) are considered to be good climbers.

Longfin eels were observed immediately upstream of the proposed reservoir footprint. Kēwai were observed throughout the stream network in the proposed reservoir including Te Ruaotehauhau Stream and Waitaia Stream. Based on aerials, there is estimated to be in the order of15 km of stream habitat upstream of the proposed reservoir. Of that, there is estimated to be ~4 km of partly shaded, permanent and intermittent stream habitats in the upper portions of Waitaia Stream and Tributary 1. The remaining ~11 km appears to be relatively open channels, with little shading and no intact riparian margins.

Common bullies, however, were only observed in the gentle portions of the stream network in the proposed reservoir footprint. Therefore, the provision of fish passage (upstream and downstream) into the proposed reservoir is recommended for eels and kēwai to enable access to the habitat within and upstream of the reservoir. An elver pass for eels and installation of a spat rope for kēwai could be constructed up the face of the dam. If this was not feasible then a trap and haul programme could be established to stock the reservoir with elvers, noting that the long-term costs of this approach would quickly exceed those of constructing an elver pass. Providing downstream passage for migrant adult eels is more problematic but this could be managed by undertaking a periodic trap & haul programme. Consideration for downstream movement of migrant eels and upstream movement of kēwai should be included in spillway design to minimise the potential for injuries to occur. Providing passage is important to realising the compensatory replacement of stream habitat for eels with lake habitat in the reservoir and given the extent of upstream habitat remaining following completion of the reservoir.

It is recommended that upstream and downstream fish passage for eels be included in the design of the reservoir. This approach will be the most cost-effective in the long term and is critical to enabling the use of the proposed reservoir habitat by eels to compensate for the loss of stream habitat that will occur. It is recommended that fish passage is not provided for

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[16] Franklin, P., Gee, E., Baker, C. & Bowie, S. (2018). New Zealand Fish Passage Guidelines for Structures up to 4 metres. NIWA CLIENT REPORT No: 2018019HN.

[17] Stevenson, C., Baker, C. (2009). Fish passage in the Auckland Region – a synthesis of current research. Prepared by NIWA for Auckland Regional Council. Auckland Regional Council Technical Report 2009/084.

[18] Baker, C., Smith, J., & Davison, B. (2008). Hunua Ranges Dams – Freshwater Fish Survey (Auckland Regional Council Technical Report 2008/016). Prepared by NIWA for Auckland Regional Council and Watercare Services Ltd.

[19] Smith, J. (2014). Freshwater fish spawning and migration periods. MPI Technical Paper No: 2015/17. NIWA, prepared for Ministry for Primary Industries.

swimming species, to prevent the potential movement of pest fish species into the reservoir. Approval of any fish pass design or dispensation to not install a fish pass is required from the Director-General of the Department of Conservation under Section 43 of the Freshwater Fish Regulations 1983.

Longfin eels are classified as At Risk – Declining, meaning that the potential affected fauna is of **high** ecological value. Longfin eels are accomplished climbers and are typically found to inhabit headwater catchments, therefore the magnitude of effect caused by impeding fish passage is considered **moderate**. This would result in an overall level of effect of **high**, but further dam design to incorporate eel passage is recommended to enable passage and contribute to the compensation package resulting from stream habitat loss.

4.2.4 Permanent modification of stream habitat

The proposed reservoir will inundate the gully system resulting in modification of approximately 2,114 m (~5,285 m^2 streambed area) continually flowing permanent stream and approximately 538 m (~108 m^2 streambed area) of intermittently flowing stream. The length and area of stream bed affected has been estimated based on stream length identified during our site visit and bank full widths after heavy rainfall, therefore will require confirmation on site to determine the actual extent. The filling of the reservoir will impact the main stems and tributaries across the site, turning them from relatively natural, hard-bottom streams to lake type habitat.

Due to the nature of the effect, being a substantive change to the functionality of the stream system, the effects are difficult to mitigate at the point of impact. Even though the construction of a reservoir will likely provide additional habitat, the habitat is not the same as stream habitat. Therefore, measures are required to address the effects associated with the loss of stream habitat.

The stream habitat is considered to have **high** ecological value based on a combination of natural hard-bottom streams, good to excellent macroinvertebrate community scores, the fish community observed with the presence of longfin eels, and estimated stream function SEV scores. The magnitude of effects is considered **very high** due to the permanence and quantity of stream loss. Therefore, the overall level of effects from the permanent loss of stream habitat is **very high**.

4.2.4.1 Restoration length required

To define the quantum of enhancement or restoration required to offset the effects of the proposed reservoir, an environmental compensation ratio (ECR) can be calculated using SEV scores.

The ECR is a tool used to quantify the amount of streambed area that is required to be restored, which takes into account the extent and type of stream impacted or lost and the type of enhancement works proposed. The objective is to achieve a 'no-net-loss' in ecological function as a result of the activities. The ECR calculation formula requires SEV scores to be calculated for both the impact and proposed mitigation (or offset, if applicable) sites. This provides a basis from which to quantify and scale the likely loss in values and functions at an impact site with the increase in stream ecological values and functions at a compensation or mitigation site.

ECR = [(SEVi-P – SEVi-I) / (SEVm-P – SEVm-C)] × 1.5

Where:	*SEVi-P is the potential SEV value for the site to be impacted.* *SEVi-I is the predicted SEV value of the stream to be impacted after impact.*
	SEVm-C is the current SEV value for the site where environmental compensation is applied. *SEVm-P is the potential SEV value for the site where environmental compensation is applied.*

Restoration length required = (impact area × ECR) / restoration channel width.

Table 6 presents the summary SEV scores for the estimated current (SEVi-C) and modelled potential (SEVi-P) values for the impact permanent (SEV1 and SEV2) and intermittent (SEV3) reaches. Fish fauna intact (FFI) and invertebrate fauna intact (IFI) are excluded from the estimated current SEV score for the purpose of ECR calculations. All other streams on site are similar in their characteristics, and so the estimated SEV scores are applied as follows:

- Te Ruaotehauhau Stream (under riparian canopy) is representative of permanent channels with riparian vegetation margins,
- Te Ruaotehauhau Stream (open channel with no riparian canopy) is representative of permanent channels lacking riparian vegetation margins, and
- Tributary 2 is representative of all intermittent tributaries.

Potential scores for the impact streams have been modelled on a maximum 20 m riparian enhancement planting of native woody vegetation. The assumptions applied also include improvements to the following functions in the SEV: Vlining, Vrough, Vshade, Vdod, Vripar, Vmacro, Vsurf, Vripfilt, Vphyshab, and Vwatqual. Assumptions applied to the estimated current SEV scores and modelled potential SEV scores for SEV1, SEV2, and SEV3 are provided in Appendix E.

Impact scores (SEVi-I) are considered to be 0.2, because while the inundation of the stream will result in a permanent loss of stream habitat type, the resulting reservoir feature will still provide habitat for the fish and macroinvertebrate species observed on site and so it provides some functional value.

Table 6: Estimated and modelled stream ecological valuation (excluding FFI and IFI functions) results used to determine the estimated ECR.

Stream ID	SEV ID	SEVi-C	SEVi-P	SEVi-I	SEVm-C[20]	SEVm-P[20]
Te Ruaotehauhau Stream (under riparian canopy)	SEV1	0.78	0.88	0.2	0.46	0.86
Te Ruaotehauhau Stream (open channel with no riparian canopy)	SEV2	0.44	0.86	0.2	0.46	0.86
Tributary 2	SEV3	0.61	0.75	0.2	0.61	0.75

An estimated area of 5,393 m^2 streambed area will be impacted by the reservoir along 2,114 m of permanent and 538 m of intermittent stream.

While an offset planting location(s) has not yet been identified and confirmed, hypothetical SEVm-C and SEVm-P scores (using estimated SEV scores across site) have been used to estimate the quantum of stream offset required to achieve no net loss of ecological function.

Based on the hypothetical SEV values in Table 6 and 7, an estimated ECR of 2.4 for permanent channels with riparian vegetation margins, 2.4 for permanent channels without riparian vegetation margins, and 5.9 for intermittent channels is calculated. This means approximately 12,671 m^2 and 634 m^2 (collectively 13,305 m^2) of similar permanent and intermittent streambed area habitat enhancement in nearby catchments in Kaikohe is required to achieve no net loss of ecological function.

The ECR could be higher if streams in nearby catchments differ in stream functions from that estimated on site and SEV gains are less, which is likely if planting alongside highly modified stream channels, or infill planting into existing vegetation. Consequently, the quantum of streambed area required will increase or decrease accordingly to achieve no net loss of ecological function.

Once COVID19 restrictions are lifted and site visits can occur, SEV from representative streams will be collected and the SEV values will need to be updated. Offset stream locations will also need to be identified, and SEV's undertaken at these sites. SEV scores from the offset streams and ECR calculations will need to be updated to determine the quantum of riparian enhancement required to achieve no net loss ecological function.

It is considered that the effects associated with habitat modification can be offset by enhancing existing stream systems, the quantum of which will be calculated using the SEV and ECR methodology. While the offset quantum are currently estimations,

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[20] SEVm-C and SEVm-P scores for permanent and intermittent reaches are hypothetical scores as offset locations have yet to be identified. It is assumed that the impact reaches are similar to nearby streams in the Te Ruaotehauhau Stream catchment.

the estimated SEV scores are consistent with reference SEV scores[4] in rural catchments dominated by agricultural land-use practices.

The estimated recommended offset requirements are considered positive effects, so cannot contribute to reducing the magnitude of adverse effect. As such the magnitude of effects remains the same as 'before mitigation' (being **very high**) and subsequently the overall level of effects remain **very high**. Notwithstanding, the proposed offset package measures outlined above are recommended to be consistent with biodiversity offsetting principles.

A Stream Offset and Compensation Enhancement Planting Plan (SOCEP) is recommended to identify the location(s) of the proposed planting, updated current on site SEV scores, updated offset SEV scores and ECR calculations, species list, size, spacing, and weed maintenance programme to support the establishment of plantings.

Table 7: Estimated potential SEV scores and ECR's and offset areas required to achieve no net loss of ecological function for the proposed inundation of permanent and intermittent streams across the proposed MN06 reservoir footprint.

Impact Sites Stream ID	SEVi-C	SEVi-P	Average width (m)	Length (m)	Impacted Streambed area (m2)	Stream ID	ECR*	Streambed area compensation required (m2)
Permanent streams (with riparian margins)	0.78	0.88	2.5	1,196.4	**2,991**	**Similar permanent channels (without riparian margins)**	2.4	**7,264**
Permanent streams (without riparian margins)	0.44	0.86	2.5	917.6	**2,294**	**Similar permanent channels (without riparian margins)**	2.4	**5,407**
Intermittent streams	0.61	0.75	0.2	538	**107.6**	**Similar intermittent channels**	5.9	**634**
Totals				**2,652**	**5,392.6**			**13,305**

*As described above, the ECR may increase depending on the offset site identified and the ecological gains that can be achieved.

4.2.5 Downstream water quality effects

Reservoirs can impact downstream water quality depending on how long water is stored and where outlets are located. We understand the reservoir outlet will draw water from the base of the dam. Placement of the outlet in this location will mean that residual flows will be drawn from deeper, cooler water.

An outlet drawn from deeper water is preferable to drawing water from the shallow water layers that will likely be warmer than stream flows and potentially support algal growths, which can be toxic. The downstream channels appear to be predominantly open and lacking riparian vegetation and so fauna present may be less sensitive to temperature changes. Subject to the reservoir outlet being from deeper water, we consider the effect on freshwater fauna from changes in stream temperatures will be low. Further consideration of measures to minimise potential downstream effects will be incorporated into detailed design discussions with the project engineers.

The stream habitat is considered to have **high** ecological value based on a combination of natural hard-bottom streams, good to excellent macroinvertebrate community scores, the fish community observed with the presence of longfin eels, and estimated stream function SEV scores. In the absence of well-designed outlet structures and flow management, the magnitude of effect could be **moderate** or higher. The magnitude of the potential impact on water quality is likely to be **low**, and so the overall level of effects is considered **low**, but further assessment will be required to determine the magnitude and level of effect if the outlet is designed differently from our understanding.

4.2.6 Downstream habitat effects

The construction of a reservoir will interrupt downstream transport of coarse and fine sediment and this may impact on downstream channel form and aquatic habitat as well as reduce the storage capacity of the reservoir over time[21]. The magnitude of this effect is difficult to predict, but due the small area being impacted, may be relatively small. To minimise these impacts, it is recommended that the design of the reservoir consider facilities to allow sediment flushing to occur.

The construction of the reservoir will modify the flow regime downstream of the reservoir. The reservoir will reduce overall flow volumes to the downstream reaches outside the reservoir, but minimum flows will be maintained through the dam outflow. However, flushing flows will be reduced. Modifications to the flow regime may affect fish species more indirectly through changes to water quality, periphyton cover and macroinvertebrate production. The current flow observed on site appear to be steady through the downstream extent of the on-site stream network and fast flowing in the upper tributaries and Waitaia Stream. The freshwater community downstream of the reservoir is generally tolerant of changes in flow regimes, but environmental flow investigations are recommended to fully assess the effects of changes in flow regime.

The habitat downstream of the proposed reservoir appears to be similar to that observed on site, characterised by natural hard-bottom permanent streams and lacking riparian vegetation. Therefore, the downstream habitat is considered to have a **high** ecological value. In the absence of a suitable flow regime, the magnitude of effect could be **moderate** or higher. The magnitude of this impact and the overall level of effects is likely to be **low**, but further assessment will be required to determine the magnitude and therefore the overall level of effect.

5. Terrestrial and wetland ecological assessment

5.1 Terrestrial ecological values

The Project footprint primarily consists of farm paddocks with pasture grass and exotic forest (pine, wattle, eucalyptus and redwood), as well as isolated patches of indigenous forest and wetland along stream margins and at the edges of the proposed reservoir (Appendix A, Figure 1).

Indigenous terrestrial ecosystem types identified include the following described in the following sections:

- Pūriri forest on basalt volcanic substrate (WF7.2)
- Riparian swamp forest (WF8)
- Secondary broadleaf forest with old-growth remnants (VS5)
- Tōtara treeland (AVS1)

Remnant volcanic boulderfields are distributed across the farm which historically would have provided substrate for pūriri forest ecosystems.

Stock have access to areas of pasture grass and some areas of indigenous vegetation, however much of the indigenous vegetation is fenced from stock and therefore in good ecological condition.

A small area of grazed rautahi (*Carex secta*) is present as riparian wetland along the Te Ruaotehauhau Stream margin, and kutakuta wetland (*Eleocharis sphacelata*) is present on the margin of a farm pond in the south-western corner of the proposed reservoir. Wetlands, regardless of ecological condition, are a nationally threatened ecosystem type, with 10% of the original wetland extent remaining nationally[22].

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[21] Kondolf, G. M., Gao, Y., Annandale, G. W., Morris, G. L., Jiang, E., Zhang, J., Cao, Y., Carling, P., Fu, K., Guo, Q., Hotchkiss, R., Peteuil, C., Sumi, T., Wang, H.-W., Wang, Z., Wei, Z., Wu, B., Wu, C., & Yang, C. T. (2014). Sustainable sediment management in reservoirs and regulated rivers: Experiences from five continents. Earth's Future, 2(5), 256–280. https://doi.org/10.1002/2013EF000184

[22] Belliss, S, Shepherd, J, Newsome, P, & Dymond, J (2017). *An analysis of wetland loss between 2001/02 and 2015/16*. Landcare Research Contract Report LC2798 for the Ministry for the Environment

In regard to Threatened or At Risk plant species, kānuka (*Kunzea robusta*), and rātā vines (*Metrosideros perforata* and *M. diffusa*) were observed which are classified as Threatened – Nationally Vulnerable[23] due to the potential threat of myrtle rust. Similarly, mānuka (*Leptospermum scoparium*) is present in low abundance and is classified as At Risk – declining due to the threat of myrtle rust. Five swamp maire (*Syzigium maire*) were identified in the proposed footprint which are classified as Threatened – Nationally Critical.

Species lists and photographs of each ecosystem type are presented in Appendix F and Appendix G, respectively.

5.1.1 Pūriri forest (WF7.2)

Pūriri forest is present as fragmented patches of mature native forest in the outlying landscape and is generally fenced and protected from stock access. Mature pūriri forest is present on the margins of the proposed reservoir and is present as remnant patches along some of the riparian margin to Te Ruaotehauhau Stream and its side tributaries. Pūriri forest extents at Tributary 2 are surrounded by exotic pine forest.

Pūriri forest has established on basaltic volcanic rock substrate and consists of large canopy trees pūriri (*Vitex lucens*), taraire (*Beilschmiedia tarairé*), tōtara (*Podocarpus totara*), rewarewa (*Knightia excelsa*) and karaka (*Corynocarpus laevigatus*), generally with degraded understorey due to stock damage. Where the understorey is intact it consists of māhoe (*Melicytus ramiflorus*), mapou (*Myrsine australis*), nikau (*Rhopalostylis sapida*) and kawakawa (*Piper excelsum*. Tree ferns and ground ferns are present in this ecosystem type and include mamaku (*Cyathea medularis*) silver fern (*Cyathea dealbata*), kiokio (*Parablechnum novae-zelandiae*) and rasp fern (*Doodia australis*).

Epiphytes of tank lily (*Astelia hastata*), perching lily (*Astelia solandri*) and tawhirikao (*Pittosporum cornifolium*) were observed on the branches of mature trees. Tawhirikao was observed only on pūriri trees outside of the reservoir footprint.

The proposed reservoir extent affects small extents at the edges of this forest type at the southern, western and eastern sides, while avoiding high-value interior forest.

Mature pūriri forest is one of Northland’s rarest ecosystem types, with 1000 ha remaining and less than 50 ha protected. Volcanic broadleaf forests (e.g. pūriri forest) has been identified as a priority area for protection[24]. This forest type typically supports indigenous lizards, keystone birds such as kukupa (*Hemiphaga novaeseelandiae*) and can provide habitat to native bats and kauri snails. It is therefore considered as having **very high** ecological value.

5.1.2 Riparian swamp forest (WF8)

Riparian swamp forest is present on the margins of Te Ruaotehauhau Stream and consists of a canopy of māhoe, towai (*Weinmannia sylvicola*), tōtara, taraire and swamp maire, with remnant pūriri trees on the drier margins. Other species in this ecosystem type include marbleleaf (*Carpodetus serratus*), pate (*Schefflera digitata*) and ferns wheki (*Dicksonia squarrosa*), mata (*Histiopteris incisa*), thread fern (*Icarus filiforme*), gully fern (*Pneumatopteris pennigera*), smooth shield fern (*Parapolystichum glabellum*), hanging spleenwort (*Asplenium flaccidum*) and shining spleenwort (*Asplenium oblongifolium*). Epiphytes and vines include tank lily and rātā vines (*Metrosideros perforata* and *M. diffusa*) and the native ground cover, basket grass (*Oplismenus hirtillus* subsp. *Imbicillus*) is abundant.

Kahikatea (*Dacrydium dacrydioides*) is present alongside mānuka at a small portion of stock-degraded swamp forest at the upstream end of Tributary 1A.

The margins of the swamp forest also contain areas of taro (*Colocasia esculenta*), which were historically cultivated in the catchment.

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[23] De Lange, P. J., Rolfe, J. R., Barkla, J. W., Courtney, S. P., Champion, P. D., Perrie, L. R., Beadel, S. M., Ford, K. A., Breitwieser, I., Schönberger, I., Hindmarsh-Walls, R., Heenan, P. B. & Ladley, K. (2017). Conservation status of New Zealand indigenous vascular plants. New Zealand Threat Classification Series 22. 82 p.

[24] Conning, L. and Miller, N. (2000). Natural areas of Kaikohe Ecological District Reconnaissance Survey Report for the Protected Natural Areas Programme. Department of Conservation. 29pp.

Exotic species are present on the edge of this habitat including german ivy (*Delairea odorata*), however the areas are predominantly fenced from stock access and are in good ecological condition, with full understorey and canopy.

Swamp forest habitats have reduced in extent nationally due to the draining of wetlands and habitat clearance. Swamp forest is regionally under-represented with two intact examples left in the Ecological District, constituting 1.5% of natural areas left in the Ecological District.

The presence of Threatened – Nationally Critical swamp maire further increases the quality and importance of this habitat. A total of five swamp maire were identified (Appendix A, Figure 1); the swamp maire are mature and in good health, the largest being of 60 cm DBH (Diameter at Breast Height).

This ecosystem type is therefore considered of **very high** ecological value.

Swamp maire and rātā vines individually are classified as having **very high** ecological value and mānuka as **high** ecological value due to their threat classifications of Threatened and At Risk – declining respectively.

5.1.3 Secondary broadleaf forest with old-growth remnants (VS5)

Secondary broadleaf forest buffers Te Ruaotehauhau Stream and consists of a typical suite of indigenous broadleaf species. The canopy consists of kawakawa, hangehange, mapou, māhoe, kānuka, mamaku, and wheki with occasional old-growth pūriri, tōtara, taraire, rewarewa and tōwai. Kōtukutuku (*Fuchsia excorticata*) was present adjacent to stream banks, and bracken (*Pteridium esculentum*) buffers open edges.

Vines present include supplejack (*Rhopalostylis sapida*), New Zealand passionfruit (*Passiflora tetrandra*), large-leaved pohuehue (*Muehlenbeckia australis*) while ground covers include parataniwha (*Elatostema rugosum*) and ferns such as rasp fern. Exotic plants are present on the edges of this habitat type, including german ivy.

Overall, this habitat is in good ecological condition with stock exclusion resulting in regeneration of indigenous broadleaved species among remnant mature trees. Secondary broadleaf forests provide habitat for indigenous bats, birds, lizards and kauri snails. The relatively small extent of this ecosystem type, and predominantly regenerating nature result in this ecosystem being considered of **moderate** ecological value.

Kānuka is considered as having **very high** ecological value due to its threat classification of Threatened – nationally vulnerable.

5.1.4 Tōtara treeland (AVS1)

Tōtara treeland consisting of mature tōtara trees with degraded understorey is present at the north-western and south-eastern corners of the proposed reservoir footprint. Understorey regeneration appears to have been limited both by stock access and exotic pine litter, however common indigenous understorey species are present, including māhoe, pigeonwood (*Hedycarya arborea*) and kawakawa. Where the tōtara treeland meets the riparian margin of the stream, New Zealand flax (*Phormium tenax*) is present. Wild ginger (*Hedychium gardnerianum*) is present in some areas but in low abundance.

No threatened or at-risk species were present in this ecosystem type, but tōtara treelands may provide habitat for native bats, birds and lizards and are therefore considered of **moderate** ecological value. Tōtara treelands are currently providing buffering and shading to Waitaia Stream and Te Ruaotehauhau Stream.

5.1.5 Volcanic boulderfields

Distributed across the pasture grass areas are remnant volcanic boulders lacking in vascular vegetation.

Volcanic boulderfield substrates are an historically rare terrestrial ecosystem type with a total extent of <0.5% nationally. Volcanic boulderfields (even without vegetation) are classified as an endangered ecosystem type[25] and provide important substrate for rare pūriri forest ecosystems.

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[25] Wiser, S. K., Buxton, R. P., Clarkson, B. R., Hoare, R. J., Holdaway, R. J., Richardson, S. J., ... & Williams, P. A. (2013). New Zealand's naturally uncommon ecosystems. *Ecosystem services in New Zealand: conditions and trends. Manaaki Whenua Press, Lincoln*, 49-61.

The volcanic boulderfields are severely degraded due to stock impacts and provide little habitat to native fauna. However native skinks may utilise boulders as shelter and basking, and due to their status as endangered are therefore classified as having **high** ecological value.

5.1.6 Exotic forest

Exotic forest is present across the proposed reservoir footprint, and consists of mature wattle (*Acacia* spp.), pine (*Pinus radiata*), eucalyptus (*Eucalyptus* sp.) and a small area of redwood (*Sequoia sempervirens*).

The understorey of these forest types is spare, having been grazed by stock. Some areas beneath pine and wattle are dominated by the exotic ground cover tradescantia (*Tradescantia flumenensis*). Tradescantia may provide suitable habitat for native skink species. Areas of pine in the south-eastern corner have recently been cleared.

Exotic forestry is used by long-tailed bats and North Island brown kiwi as foraging and roosting habitat. For the purposes of this assessment we have conservatively assumed that indigenous bats and North Island brown kiwi are present and therefore exotic forest is classified as having **moderate** ecological value.

A moderate ecological value was determined through following the EIANZ guidelines, specifically assigning:

- A **low** value for representativeness (e.g. exotic-dominated ecosystem);
- A **high** value for rarity/distinctiveness (e.g. Threatened long-tailed bats and At Risk North Island brown kiwi may be present);
- A **low** value for diversity and pattern (e.g. low overall indigenous diversity); and,
- A **moderate** ecological value in regards to ecological context (e.g. provides a moderate value stepping stone for forest birds, provides some buffering to streams, and are of a relatively large size considered together).

Therefore, the area rates h**igh** for one of the assessment matters and **low** or **moderate** for the remainder, resulting in an overall **moderate** ecological value.

5.1.7 Indigenous-dominated wetlands

Indigenous-dominated wetlands are present on site including a small section of rautahi (*Carex geminata*) and a small artificial pond (Constructed Wetland) dominated by kutakuta (*Eleocharis sphacelata*) buffered by ring fern (*Paesia scaberula*). Both wetlands were compromised by stock grazing and hydrological modification from exotic trees and weeds.

Wetlands, regardless of condition are a nationally threatened ecosystem. Given that the wetlands were of a small extent but dominated by indigenous species, both are considered as having **high** ecological value.

Under the criteria set out in Appendix 5 of the Regional Policy Statement for Northland, none of the wetlands on site are classified as being Significant. Nevertheless, the rautahi wetland is considered natural and therefore captured under the provisions of the recently gazetted National Policy Statement for Freshwater Management 2020 and National Environmental Standards for Freshwater 2020. The kutakuta wetland is considered a Constructed Wetland due to evidence of excavation and the creation of a bund for wetland creation, potentially for an historic detention dam or water supply.

5.1.8 Wet pasture grass

Areas of wet pasture grass dominated by exotic pasture species, as well as small *Juncus effusus* wetlands are present across the site. Under the Proposed Regional Plan for Northland pasture wetlands dominated by rushes are not considered a ‘Natural Wetland’ and are therefore considered of **low** ecological value.

5.1.9 Bats

Potential roost habitat for long-tailed bats is present within the Project footprint within the following ecosystem types:

- Pūriri forest;
- Swamp forest;

- Secondary broadleaf forest with old-growth signatures; and,
- Exotic forest

Pūriri forest contains mature native trees (over 1.5 m DBH) with abundant cracks and crevices available for long-tailed bat roosting. Pūriri and swamp forest host perching epiphytes such as tank lily which long-tailed bats may use for roosting. Old-growth trees in the secondary broadleaf forest contain cracks and crevices for long-tailed bat roosting, as well as providing native vegetation overhanging Waitaia Stream and Te Ruaotehauhau Stream which creates a suitable fly-way for bats.

Pine, wattle, redwood and eucalypt trees are large (above 40 cm DBH) and cracks and crevices were identified during the site visit which may provide suitable roosting habitat for long-tailed bats.

Furthermore, linear features and a wetland gully corridor provides a suitable potential flyway of approximately 185 m within the pūriri forest along Tributary 2 (Appendix A Figure 1), which may be used by bats for foraging. A potential fly-way of approximately 1 km length may be used for foraging and/or commuting along Waitaia Stream and Te Ruaotehauhau, with approximately 50% of the stream riparian margin vegetated.

Indigenous and exotic vegetation is distributed patchily across the outlying landscape, and these patches may provide a mosaic of roosting and foraging habitat for long-tailed bats.

Short-tailed bat populations are known from contiguous areas of mature native forest and are unlikely to be found within fragmented forest in farmland environments, however acoustic bat surveys will be undertaken to investigate their possible presence.

Acoustic surveys are required to determine whether bats are present at this site. No acoustic bat surveys have yet been undertaken within the footprint, however for the purposes of this assessment we have assumed conservatively that both long-tailed and lesser short-tailed bats are present. Due to both species having a conservation threat status of Threatened[26], they are considered as having **very high** ecological value.

5.1.10 Avifauna

Overall, seven bird species were identified during the site walkover and bird counts which included five native species. In general, the avifauna community was typical of farmland with fragmented patches of indigenous and exotic forest.

Indigenous birds included kukupa (*Hemiphaga novaeseelandiae*) tūī (*Prosthemadera novaeseelandiae*), riroriro (*Gerygone igata*), pīwakawaka (*Rhipidura fuliginosa*), and silvereye (*Zosterops lateralis*) and exotic birds eastern rosella (*Platycercus eximius*) and common myna (*Acridotheres tristis*). Of these, kukupa are considered Regionally Significant[27].

Assessment for the Kopenui Stream Reservoir Assessment of Ecological Effects approximately 4 km away identified miromiro (*Petroica macrocephala*) as present, and it is conservatively assumed they would utilise the habitat on site. Miromiro are considered of Regional and District significance**Error! Bookmark not defined.**.

The location of the site is immediately adjacent to known North Island brown kiwi distribution areas including a ‘High Density’ area. It is conservatively assumed that North Island brown kiwi utilise the site, either permanently or intermittently as part of a series of stepping stones throughout the landscape. No kiwi burrows or signs were observed during the site visit, however burrows can be cryptic, and areas of exotic forestry were not explored fully during the walkover. North Island brown kiwi may utilise the indigenous and or exotic vegetation on site for foraging and roosting, are classified as At Risk – declining and are Regionally Significant**Error! Bookmark not defined.**. Given the size of the site (approximately 30 ha), multiple kiwi pairs may use the site a s part of their territory.

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[26] O’Donnell, C.F.G., Borkin, K.M., Christie, B. L., Parsons, S., Hitchmough, R. A. (2017). Conservation status of New Zealand bats. New Zealand Threat Classification Series 21. 4 p.

[27] Conning, L. and Miller, N. (2000). Natural areas of Kaikohe Ecological District Reconnaissance Survey Report for the Protected Natural Areas Programme. Department of Conservation. 29pp.

Miromiro, kukupa and North Island brown kiwi are considered as having **high** ecological value as they are considered Regionally Significant.

Tūī are considered as having **moderate** ecological value as a key pollinator and seed disperser. All other Not Threatened and exotic birds observed during the site visit are considered as having **low** ecological value as they are common in the wider landscape.

Rank grass provides nesting habitat for New Zealand pipit (*Anthus novaeseelandiae*) and although not observed during the site visit, they may intermittently use the site. New Zealand pipit are classified as At Risk – declining and therefore of **high** ecological value.

5.1.11 Herpetofauna

No herpetofauna were observed during the site visit; but lizards are normally active during warmer months, and therefore should be surveyed between October and April.

Through desktop assessment and assessment of habitat on site, six herpetofauna species were identified as potentially utilising the site. These include, nationally At Risk – Declining[28] forest gecko (*Mokopirirakau granulatus*), elegant gecko (*Naultinus elegans*), Northland green gecko (*Naultinus grayii*), ornate skink (*Oligosoma ornatum*), nationally At Risk – Relict Pacific gecko (*Dactylocnemis pacificus*) and Not Threatened copper skink (*Oligosoma aeneum*). At Risk – Declining, At Risk – relict and Not Threatened herpetofauna are considered as having high, moderate, and low ecological values, respectively. Furthermore, ornate skinks are considered Regionally significant**Error! Bookmark not defined.**.

Skink habitat was identified on site as consisting of the following microhabitats:

- Rank grass habitat where stock have been unable to graze;
- Tradescantia ground cover beneath exotic trees;
- Boulderfields which provide shelter though cracks and crevices, as well as providing basking habitat;
- Indigenous forest types which provide leaf litter and boulder microhabitats.

Gecko habitat was identified on site as consisting of indigenous terrestrial vegetation including mature native and secondary broadleaf forest. Regenerating and mature native trees provide food and shelter resources for indigenous geckos.

The fragmented habitat with poor connectivity to large contiguous areas of forest and the likely presence of pest mammals on site reduces the likelihood of herpetofauna presence. If present, it is expected that herpetofauna will be in low or moderate abundance.

If present, forest gecko, elegant gecko, Northland green gecko and ornate skink are considered as having **high** ecological value, Pacific gecko as **moderate** ecological value and copper skinks as **low** ecological value due to their threat classifications.

5.1.12 Invertebrates

Kauri snails (*Paryphanta busbii*) have been found within 5 km of the site[29] and it is considered that indigenous forest habitats on site may provide suitable habitat for kauri snails as the leaf litter remains intact in some areas due to stock exclusion fencing.

Kauri snails are classified as a Threatened and regionally significant snail**Error! Bookmark not defined.** and are protected by the Wildlife A ct 1953. Due to their regional distinctiveness kauri snails are considered of **high** ecological value.

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[28] Hitchmough, R., Barr, B., Lettink, M., Monks, J., Reardon, J., Tocher, M., van Winkel, D. & Rolfe, J. (2015). Conservation status of New Zealand reptiles. New Zealand Threat Classification Series 17. 14 p.

[29] Inaturalist (2019). Kauri snail (*Paryphanta busbyii*). Accessed on 20 August 2020 from https://inaturalist.nz/observations/36010613

5.2 Assessment of ecological effects - terrestrial

5.2.1 Vegetation effects

It is expected that all vegetation within the reservoir footprint will be removed. The total quantity of indigenous vegetation loss is 1.46 ha, with an additional 0.75 ha of volcanic boulderfield, 1.32 ha of exotic forest and 0.22 ha of wet pasture removal.

This includes a total of:

- 0.47 ha of pūriri forest;
- 0.32 ha of swamp forest;
- 0.44 ha of secondary broadleaf forest with old-growth signatures;
- 0.14 ha of tōtara treeland;
- 0.75 ha of volcanic boulderfield;
- 0.03 ha of rautahi wetland;
- 0.05 ha of kutakuta wetland;
- 1.32 ha of exotic forest; and
- 0.22 ha of wet pasture.

Without mitigation, removal of vegetation will result in the loss of habitat and foraging resources for indigenous fauna, potential mortality of indigenous fauna, increased landscape fragmentation and loss of connectivity, and the loss of nationally threatened wetland habitats and indigenous plant species.

5.2.1.1 Magnitude and overall level of effect

This section outlines the predicted magnitude of effect on each of the affected ecosystem types, Threatened and At Risk plant species and fauna. Through combining the magnitude of effect with the ecological value of the focal characteristic, the overall level of ecological effect is determined.

Removal of 0.47 ha pūriri forest is considered a **moderate** magnitude of effect for this habitat. A **very high** ecological value combined with a **moderate** magnitude of effect results in an overall **high** ecological effect.

Removal of 0.32 ha swamp forest is considered a **moderate** magnitude of effect for this habitat. A **very high** ecological value combined with a **moderate** magnitude of effect results in an overall **high** ecological effect.

Removal of 0.44 ha secondary broadleaf forest with old-growth signatures is considered a **moderate** magnitude of effect for this habitat. A **moderate** ecological value combined with a **moderate** magnitude of effect results in an overall **moderate** ecological effect.

Removal of 0.14 ha tōtara treeland is considered a **moderate** magnitude of effect for this habitat. A **moderate** ecological value combined with a **moderate** magnitude of effect results in an overall **moderate** ecological effect.

Removal of 0.75 ha of volcanic boulderfield is considered a **moderate** magnitude of effect for this habitat. A **high** ecological value combined with a **moderate** magnitude of effect results in an overall **high** ecological effect.

Removal of 1.2 ha of exotic forest is considered a **moderate** magnitude of effect for this ecosystem, as pine is common in the wider landscape, however permanent removal of a substantial quantity of vegetation is proposed. A **moderate** ecological value with a **moderate** magnitude of effect results in an overall **moderate** ecological effect.

Removal of 0.03 ha rautahi wetland is considered a **low** magnitude effect due to the small quantity of wetland loss. A **high** ecological value combined with **low** magnitude of effect results in an overall **low** ecological effect.

Removal of 0.05 ha of kutakuta wetland is considered a **low** magnitude of effect due to the low quantity of wetland loss. A **high** ecological value combined with **low** magnitude of effect results in a **low** ecological effect.

Removal of nationally Threatened swamp maire constitutes a **high** magnitude of effect due to the permanent removal of trees which only remain in small, fragmented populations nationally and which are experiencing ongoing loss. A **very high** ecological value with a **high** magnitude of effect results in a **very high** ecological effect.

Removal of kānuka, rātā vines and mānuka individuals constitutes a **low** magnitude of effect as these species are common locally and nationally and few individuals are being affected. A **very high** ecological value with a **low** magnitude of effect results in a **moderate** ecological effect for kānuka and rātā vines, and a **high** ecological value with a **low** magnitude of effect results in a **low** ecological effect to mānuka.

Removal of 0.22 ha of wet pasture is considered a **low** magnitude effect due to the small amount of wet pasture loss. A **low** ecological value combined with **high** magnitude of effect results in a **low** ecological effect.

5.2.1.2 Vegetation effects management

Residual effects resulting from vegetation removal can be offset and compensated through revegetation planting and enhancement of existing ecosystems which may be degraded. Such enhancement might include planting, pest control, and the provision of coarse woody debris or boulders for indigenous fauna.

Management plans will be required prior to construction in order to remedy, offset and compensate impacts to vegetation and habitats. The following management plans are recommended:

› Final terrestrial offset and compensation package, outlining the quantum of planting or other compensation measures required to account for the loss of terrestrial and wetland habitats, including the use of offsetting guidance (see Section 5.2.1.3). Offset and compensation is recommended to include restoration planting and habitat enhancement. Further field surveys and community engagement will be undertaken to inform the offsetting package.

› Development of a Restoration Management Plan detailing the extents and areas for replanting, planting proportions and densities, planting specifications and a plant maintenance regime.

Effects to Threatened and At Risk plants will be offset and compensated through revegetation plantings. Effects to swamp maire will be offset through replacement at a ratio of 1:200. Effects to mānuka and kānuka will be addressed by including these species as a high proportion of the replacement planting crop. It is expected that rātā vines will re-establish through seed colonisation in time.

Additional site visits will include targeted searching of swamp forest to identify swamp maire that may have been missed during the initial survey. All swamp maire will be measured and recorded.

It is recommended that impacts to volcanic boulderfields be remedied through the relocation of boulders which are inside the footprint to the edge of the proposed reservoir where practicable. Boulders will be effective in providing potential:

› Skink habitat enhancement;

› Kauri snail habitat enhancement; and

› Provision of substrate for pūriri forest offset planting.

5.2.1.3 Biodiversity accountancy offsetting model

The Biodiversity Offset Accounting Model[30] (BOAM) has been developed to provide a transparent, robust, and structured means of assessing an offset proposal. Based on data inputs, the model calculates whether a 'no-net-loss'/'net-gain' biodiversity outcome will be achieved, whilst accounting for uncertainty and time lag between loss at impact sites and gain being created at offset sites. In summary, the model:

› Accounts for 'like-for-like' biodiversity trades/currencies aimed at demonstrating 'no-net-loss' or 'net-gain';

› Calculates the present biodiversity value to estimate whether 'no-net-loss' or 'net-gain' can be achieved;

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[30] Maseyk et al. (2015). A Biodiversity Offsets Accounting Model for New Zealand. Contract report prepared for the Department of Conservation, Hamilton Service Centre Private Bag 3072 Hamilton New Zealand

- Incorporates the use of a time discount rate to account for time lag. We will use a discount rate of 3% to account for the temporal-lag between the impact occurring (due to the development) and the biodiversity gains being generated (due to the offset actions). The worked examples provided in the User Manual apply a discount rate of 3%, as informed by research conducted as part of DOC's research project on biodiversity offset in New Zealand; and,
- Makes an allowance for uncertainly of success (i.e. a degree of confidence) in relation to proposed offset actions.

Data will be collected from the impact areas which will inform offset models. An offset site will also be identified which provides opportunity to enhance like for like habitat to those being impacted.

To inform offset models, 10 x 10 m^2 RECCE plots[31] will be undertaken in representative areas of each of the indigenous ecosystem types. Attributes of the vegetation in each RECCE plot will be measured and will include canopy height, canopy cover, Diameter at Breast Height of each tree above 2.5 cm DBH, species richness, as well as fauna proxy measures including the number of flaky bark trees and leaf litter depth.

Biodiversity offsetting and compensation preliminary results

Offset modelling of similar ecosystem types has been undertaken on other projects, and these have been used to estimate the likely offsetting ratio required for each ecosystem with an overall level of effect of moderate of higher.

The effects on rautahi wetland are low, however the Proposed Regional Plan for Northland states that activities must not cause changes to the water level of any Natural Wetland to an extent that may cause adverse effects to the natural ecosystem (C.2.3 Natural wetlands). Therefore, it is proposed that effects to the rautahi wetland also be offset. The kutakuta wetland is considered a Constructed Wetland and as such offsetting is not proposed.

These are summarised in the Table 8.

Table 8: Surrogate estimations of likely offsetting ratio at MN06 which as a result of the proposed reservoir, have an ecological effect of moderate or higher (with the addition of rautahi wetland).

Ecosystem type	Reference model	Reference ecosystem	Offset ratio of reference model	Estimated offset quantum (ha)
Pūriri forest	Kopenui Stream Reservoir Assessment of Ecological Effects	Podocarp-broadleaf forest	1:8	3.76
Swamp forest	Kopenui Stream Reservoir Assessment of Ecological Effects	Swamp forest	1:4	1.28
Secondary broadleaf forest with old-growth signatures	Manawatū Tararua Highway Proposed Conditions of the Resource Consents	Secondary broadleaf forest with old-growth signatures	1:5.2	2.3
Tōtara treeland	Kopenui Stream Reservoir Assessment of Ecological Effects	Old-growth fragments	1:8	1.12
Rautahi wetland	Mānawatu Tararua Highway Proposed Conditions of the Resource Consents[32]	Indigenous-dominated wetland moderate value (rautahi-dominated wetland)	1:2.7	0.08
Total indigenous revegetation estimate				**8.54 ha**

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[31] Hurst, J. M., & Allen, R. B. (2007). *The recce method for describing New Zealand vegetation – field protocols*. Landcare Research.

[32] Waka Kotahi New Zealand Transport Agency (2020). Proposed Conditions of the Resource Consents –Mediation Version: 3 August 2020. Manawatū Tararua Highway.

Offset modelling in similar ecosystem types suggests a total of approximately 8.54 ha of offset planting is required to achieve net gain with associated fencing, weed and pest control (e.g. rabbit and hares) to ensure growth of new plantings. Additional field work will be undertaken to gather offset modelling data to update BOAMs and determine final offsetting requirements, and offset sites will be identified.

5.2.1.4 Measures to reduce vegetation ecological effects summary

The overall level of ecological effects on vegetation can be offset and compensated through recommendations outlined in the above sections. Implementing these recommendations in full will ensure 'No Net Loss' of vegetation values can be achieved.

5.2.2 Fauna effects

Without mitigation, vegetation removal can result in the injury or mortality of nesting birds, eggs and fledglings, roosting bats, lizards and kauri snails. Fauna Management Plans will be utilised to mitigate impacts to fauna on site and will be implemented prior to construction commencing. Fauna Management Plans will include vegetation removal protocols and seasonal vegetation clearance constraints which minimise injury and mortality to native fauna.

5.2.2.1 Magnitude and overall level of effect without management recommendations

The magnitude of effect of vegetation removal on native bats is considered **high** due to the presence of potential roost habitat loss and the potential for injury and mortality of bats during vegetation clearance. A **very high** ecological value combined with a **high** magnitude of effect results in a **very high** level of effect.

The magnitude of effect on forest birds of forest removal is considered **moderate** due to the potential of injury or mortality to breeding birds, as well as habitat loss. Forest birds are common in the landscape, therefore the magnitude of effect is considered to be moderate. For miromiro and kukupa, a **high** ecological value with a **moderate** magnitude of effect results in a **high** ecological effect.

For tūī, a **moderate** ecological value combined with a **moderate** magnitude of effect results in a **moderate** ecological effect. For other common forest birds, a **low** ecological value combined with a **moderate** magnitude of effect results in a **low** ecological effect.

The magnitude of effect on North Island brown kiwi is **high** given the possibility of mortality of kiwi during construction activities. Mortality might occur during vegetation clearance or during construction, due to higher vehicle access and the increased potential of bird strike. Adult kiwi are generally capable of escaping from disturbance, however are particularly sensitive during the kiwi breeding season (July to March inclusive). A **high** ecological value combined with a **high** magnitude of effect results in a **very high** ecological effect.

The magnitude of effect rank grass removal on New Zealand pipit is considered **moderate**, due to the potential loss of eggs or chicks during breeding season. A **high** ecological value combined with a **moderate** magnitude of effect results in a **high** ecological effect on New Zealand pipit.

The magnitude of effect on native lizards on site is considered **high** due to the potential of injury or mortality of lizards and habitat loss. A **high** magnitude of effect combined with **high** ecological values results in a **very high** ecological effect for forest gecko, elegant gecko, Northland green gecko and ornate skink. A **moderate** ecological value with a **high** magnitude of effect results in a **moderate** ecological effect for Pacific gecko. A **low** ecological value with a **high** magnitude of effect results in a **low** ecological effect on copper skinks.

The loss of potential kauri snail habitat is considered a **moderate** ecological effect. A **high** ecological value with a **moderate** magnitude of effect results in a **high** ecological effect on kauri snails.

5.2.3 Fauna effects management

5.2.3.1 Bat management

Native bat acoustic monitoring has not yet been undertaken at the Project site and survey using Automatic Bat Monitors is required between October and April to determine their presence.

It is possible that potential roost habitat within the footprint is at least intermittently used as part of a wider roost network for long-tailed bats. There is a very low possibility of short-tailed bat presence. Considering this, the possibility exists that individual bats (or in the worst case, an active communal maternity roost) may be harmed or killed during site clearance. The implementation of a Bat Management Plan (BMP) will avoid, minimise and/or mitigate potential impacts to native bats. As part of the BMP, acoustic surveys will be undertaken to investigate bat activity at the site. Depending on the findings of acoustic survey/s, a range of suitable management options may be recommended. These may include some or all of:

- Best-practice vegetation removal protocols to avoid injury or death during vegetation clearance, potentially involving further acoustic survey immediately prior to clearance, and/or climbing of trees to confirm bats are currently absent;
- Planting of tree species which may form roost habitat over time, to address the loss of potential roost habitat in the affected area;
- Planting of suitable species to replace the loss of foraging/commuting habitat within the affected area; and/or
- Pest control to protect roost habitat off site, over an appropriate area, for an appropriate length of time, to offset the loss of potential roost habitat in the affected area.

5.2.3.2 Avifauna management

The implementation of an Avifauna Management Plan (AMP) will avoid, minimise and/or mitigate effects to avifauna. The AMP will include vegetation removal protocols and bird nest check protocols. Most adult birds can fly away from construction-related impacts but are vulnerable during bird breeding season when nesting. Terrestrial vegetation should be removed outside of the peak bird breeding season (September to December inclusive) to avoid impacts to indigenous forest birds. Bird nest checks can be undertaken where low stature vegetation is to be removed during the bird breeding season.

A monitoring and management programme is proposed for North Island brown kiwi and will be detailed in the AMP. Monitoring via kiwi listening surveys will initially be undertaken to determine potential kiwi presence, locations and abundance in the Project footprint and areas immediately adjacent.

Depending on the results of the listening surveys, various management actions may be used to avoid impacts to kiwi which might include:

- Management through locating and protecting individuals living near or alongside the footprint area;
- Temporary fences to exclude kiwi from entering the construction zone;
- Searching with trained dogs prior to vegetation clearance to determine if nests are present (during the breeding season July to March inclusive)
- Removing vegetation outside of the kiwi breeding season.

5.2.3.3 Herpetofauna management

All native herpetofauna are protected by the Wildlife Act 1953. Lizards are more active during warmer months (October to April inclusive) during fine weather, and therefore vegetation clearance of lizard habitat and lizard salvaging should only be undertaken during this period to minimise impacts to lizards.

Destructive habitat searching and construction-assisted salvaging is recommended to avoid impacts to native skinks. This method will involve manually searching through tradescantia, turning over coarse woody debris, and being onsite during vegetation clearance and volcanic boulder relocation.

Spotlighting for geckos is recommended prior to the clearance of indigenous vegetation. After felling, vegetation will be searched for geckos, and vegetation left in situ beside existing indigenous forest prior to mulching.

To avoid, minimise and/or mitigate impacts to lizards, a Lizard Management Plan (LMP) will be implemented, which outlines key methodologies used to mitigate impact to skinks and geckos. The LMP will include details such as:

- Species to be targeted;
- Vegetation removal protocols and timings;

- Salvaging methodology, including destructive habitat searching for skinks and gecko spotlighting;
- Relocation site characteristics and location;
- Other mitigation measures which will benefit lizards such as restoration planting and habitat enhancement through the use of volcanic boulders; and,
- Personnel undertaking lizard salvaging.

Offset planting and the relocation of boulders from the volcanic boulderfields will be used to offset and compensate for potential loss of lizard habitat.

5.2.3.4 Invertebrate management

To avoid, minimise and/or mitigate impacts to kauri snails, an Invertebrate Management Plan (IMP) will be implemented, which outlines key methodologies used to salvage and relocate snails.

Kauri snails will be managed through destructive habitat searching prior to vegetation clearance, which involves searching through leaf litter, at the base of trees and underneath coarse woody debris.

5.2.4 Measures to reduce fauna ecological effects summary

The overall level of ecological effects on fauna with and without mitigation measures are outlined in Table 9. If the recommendations outlined in this report are implemented in full, then the overall effects to fauna on site are all considered to be '**Low'** or '**Very low**'. In addition, vegetation offset and compensation planting will provide habitat for most of the fauna being impacted.

More data is required to accurately estimate the potential level of effect on native bats. If bats are found to be using the site for roosting, or there is high bat activity, then further measures may be required to compensate for the loss of habitat within the site. The extent of this will not be known until bat monitoring is undertaken and data analysis completed. More data is also required in order to determine offsetting requirements for indigenous vegetation and North Island brown kiwi.

Table 9: Ecological effects on fauna without mitigation compared to the overall ecological effect if mitigation implemented in full. Bolded overall ecological effects have changed as a result of recommended mitigation measures.

Species	**Overall level of effect without recommended management**	**Overall level of effect with recommended management**	**Notes**
Long-tailed and northern lesser short-tailed bat	Very high	**Low**	The BMP will include vegetation removal protocols (including seasonal clearance constraints) which will avoid impacts to potentially roosting bats. The results of acoustic monitoring will also guide appropriate measures to address the loss of potential roost, foraging and commuting habitat if required.
Kukupa, miromiro	High	**Low**	Offset and compensation plantings will provide additional habitat. AMP will involve seasonal clearance constraints and bird nest checks, further reducing the magnitude of effect by avoiding disturbance and mortality impacts to nesting birds, chicks and eggs.
Tūī	Moderate	**Low**	
Other Not Threatened avifauna	Very low	**Very low**	
North Island brown kiwi	Very high	**Low**	AMP will detail kiwi monitoring and management protocols. Kiwi monitoring will determine possible kiwi presence after which appropriate management can be applied.
New Zealand pipit	High	**Low**	Seasonal clearance constraints and bird nest checks as outlined in AMP.
Herpetofauna	High	**Low**	LMP includes seasonal vegetation clearance and salvaging protocols. Salvaging protocols will include construction-assisted habitat searches and gecko spotlighting.
Forest gecko, elegant gecko Northland green gecko and ornate skink	High	**Low**	Lizard salvaging and relocation as detailed in the LMP.
Pacific gecko	Moderate	**Low**	
Copper skink	Low	**Very low**	
Kauri snail	High	**Low**	Implementation of the IMP which includes snail searching and salvaging prior to vegetation clearance.

6. Recommendations to manage effects

This assessment of ecological effects has been undertaken in the absence of a detailed construction methodology or final design details for the Water Storage Reservoir. Therefore, a variety of assumptions have been made when determining the magnitude of impact and the measures required to adequately address these effects. The actual and potential adverse effects resulting from the proposed water supply reservoir construction and operation range across freshwater and terrestrial habitats. These include:

- Sedimentation effects from construction activities;
- Injury or mortality to aquatic fauna;
- Impediments to fish passage;
- Permanent modification and loss of stream habitat;
- Impacts on water quality and habitat downstream of the proposed dam;
- Removal of threatened ecosystem types; and
- Direct and indirect effects on native terrestrial fauna.

The following recommendations are required to provide a minimum standard to address ecological effects, which are summarised in Table 10. Further measures may also be required, or a different level of detail required, to actually manage effects.

- Require a construction methodology to be developed for in-stream works that is consistent with GD05 and specifically works to minimise potential effects of deposited sediment on the hard bottom stream system.
- Develop and implement a Freshwater Fauna Salvage and Relocation Plan (FFRP) for all parts of the site where works will occur in-stream or aquatic habitat will be inundated.
- Provide for upstream and downstream passage for longfin eels in the design, construction, and operation of the reservoir.
- Consider the sediment management in the design and operation of the reservoir to minimise downstream effects and long-term storage loss.
- Undertake SEV at representative streams on site to confirm and update estimated current SEV scores (SEVi-C).
- Identify and confirm stream enhancement areas to update hypothetical SEV scores (SEVm-C and SEVm-P) and estimated ECR calculations to determine the required quantum of stream bed habitat enhancement to achieve no net of ecological function and to be detailed through a comprehensive Offset and Compensation Plan.
- Complete an environmental flows assessment to identify and manage potential effects caused by flow modification associated with the reservoir.
- Conduct RECCE plot surveys in each ecosystem type to inform Biodiversity Offsetting Accounting Models to determine offsetting quantities required to achieve Net Gain biodiversity outcomes.
- Undertake acoustic survey for native bats during warmer months (October – April inclusive). This will provide further detail on the likelihood of bats utilising the site, determine the need for further survey and inform appropriate measures to address residual effects, if required.
- Undertake monitoring of North Island brown kiwi to determine their possible use of the habitats on site.
- Exploration of suitable offset sites near to the proposed reservoir.
- Prepare and implement the following plans to manage ecological effects on site:
  - Freshwater Fauna Salvage and Relocation Plan
  - Offset and Compensation Plan to address on both freshwater and terrestrial residual effects

- Bat Management Plan
- Avifauna Management Plan
- Lizard Management Plan
- Invertebrate Management Plan

Given the size of the proposed reservoir, high value terrestrial ecosystems have largely been avoided, with the footprint encroaching only on the edges of pūriri forest habitats, and affecting a relatively small extent of secondary broadleaf forest and swamp forest.

If the above management recommendations are implemented in full, and subject to further site visits to confirm potential offset and compensation input data and areas, it is considered that effects to terrestrial and wetland ecosystems can be mitigated, offset and compensated for sufficiently, primarily through revegetation planting and fauna management plans. Similarly, effects on freshwater ecosystems and fauna can be mitigated through implementation of management plans and residual adverse effects addressed through offset or compensation measures on similar habitats in the wider catchment.

Table 10: Summary of ecological values, magnitude of effects (before and after mitigation) and overall level of effect associated with each activity.

Activity	Ecological values	Magnitude of effect (prior to management measures)	Magnitude of effects (after management measures)	Overall level of effect (if management measures implemented in full)
Sedimentation effects from construction activities	High	High	Low	Low
Injury or mortality to aquatic fauna	High	High	Low	Low
Impediments to fish passage	High	Moderate	Low	Low
Permanent modification and loss of stream habitat	High	Very High	Very High	Very High (can be offset)
Impacts on water quality and habitat downstream of the proposed dam	High	Moderate	Low	Low
Removal of threatened trees and vegetation (refer section 5.2.1 for detail)	Low to Very High	Low to High	Low to Very High	Low to Very High (can be offset and compensated)
Direct and indirect effects on native terrestrial fauna	As described in Table 9			

7. Report applicability

This report has been prepared for WWLA 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 WWLA, without our prior written agreement. We understand and agree that this report will be submitted as part of an application for resource consent and that Northland Regional Council and the Far North District Council as the consenting authorities will use this report for the purpose of assessing that application.

8. Appendices

Appendix A Ecological values and sampling locations across MN06

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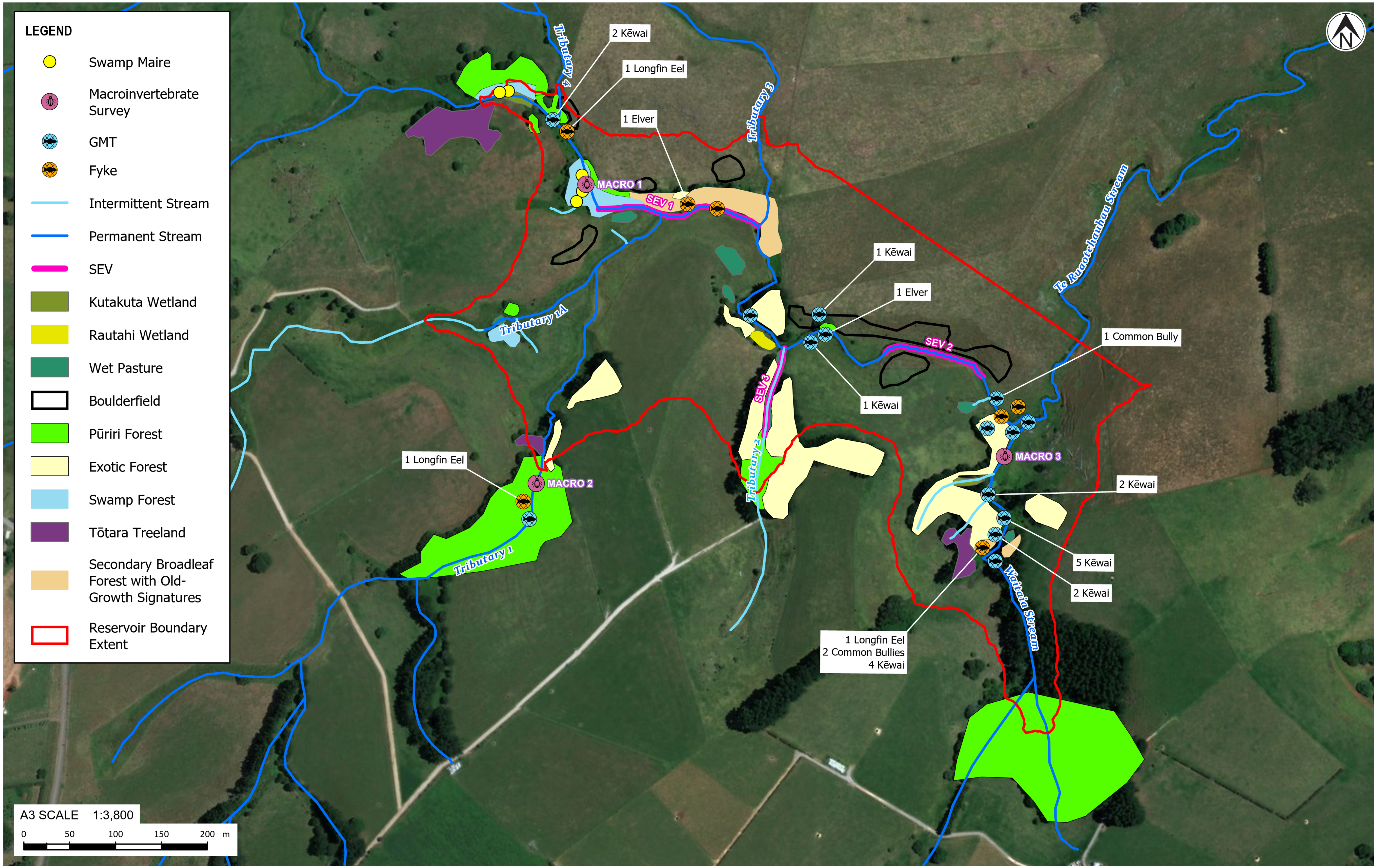

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NOTES:

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REV	DESCRIPTION	GIS	CHK	DATE
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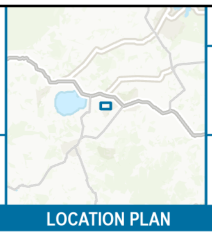

LOCATION PLAN

PROJECT No. 1012828.1000

DESIGNED	SHEG	AUG.20
DRAWN	SHEG	AUG.20
CHECKED	JORB	AUG.20

APPROVED DATE

CLIENT **PUHOI STOUR LIMITED**

PROJECT **MN06 ECO O+C**

TITLE TERRESTRIAL AND FRESHWATER ECOLOGICAL FEATURES

SCALE (A3) 1:3,800 FIG No. FIGURE 1. REV 0

Appendix B EIANZ ecological impact assessment guidelines

Factors to consider in scoring sites freshwater values in relation to species representativeness, rarity, diversity and pattern, and ecological context (adapted from EIANZ, 2018).

Value	Explanation	Characteristics
Very high	A reference quality watercourse in condition close to its pre-human condition with the expected assemblages of flora and fauna and no contributions of contaminants from human induced activities including agriculture. Negligible degradation e.g., stream within a native forest catchment.	Benthic invertebrate community typically has high diversity, species richness and abundance. Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and settled sediments. Benthic community typically with no single dominant species or group of species. MCI scores typically 120 or greater. EPT richness and proportion of overall benthic invertebrate community typically high. SEV scores high, typically >0.8. Fish communities typically diverse and abundant. Riparian vegetation typically with a well-established closed canopy. Stream channel and morphology natural. Stream banks natural typically with limited erosion. Habitat natural and unmodified.
High	A watercourse with high ecological or conservation value but which has been modified through loss of riparian vegetation, fish barriers, and stock access or similar, to the extent it is no longer reference quality. Slight to moderate degradation e.g., exotic forest or mixed forest/agriculture catchment.	Benthic invertebrate community typically has high diversity, species richness and abundance. Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and settled sediments. Benthic community typically with no single dominant species or group of species. MCI scores typically 80-100 or greater. EPT richness and proportion of overall benthic invertebrate community typically moderate to high. SEV scores moderate to high, typically 0.6-0.8. Fish communities typically diverse and abundant. Riparian vegetation typically with a well-established closed canopy. No pest or invasive fish (excluding trout and salmon) species present. Stream channel and morphology natural. Stream banks natural typically with limited erosion. Habitat largely unmodified.
Moderate	A watercourse which contains fragments of its former values but has a high proportion of tolerant fauna, obvious water quality issues and/or sedimentation issues. Moderate to high degradation e.g., high-intensity agriculture catchment.	Benthic invertebrate community typically has low diversity, species richness and abundance. Benthic invertebrate community dominated by taxa that are not sensitive to organic enrichment and settled sediments. Benthic community typically with dominant species or group of species. MCI scores typically 40-80. EPT richness and proportion of overall benthic invertebrate community typically low. SEV scores moderate, typically 0.4-0.6. Fish communities typically moderate diversity of only 3-4 species.

		Pest or invasive fish species (excluding trout and salmon) may be present. Stream channel and morphology typically modified (e.g., channelised) Stream banks may be modified or managed and may be highly engineered and/or evidence of significant erosion. Riparian vegetation may have a well-established closed canopy. Habitat modified.
Low	A highly modified watercourse with poor diversity and abundance of aquatic fauna and significant water quality issues. Very high degradation e.g., modified urban stream	Benthic invertebrate community typically has low diversity, species richness and abundance. Benthic invertebrate community dominated by taxa that are not sensitive to organic enrichment and settled sediments. Benthic community typically with dominant species or group of species. MCI scores typically 60 or lower. EPT richness and proportion of overall benthic invertebrate community typically low or zero. SEV scores moderate to high, typically less than 0.4. Fish communities typically low diversity of only 1-2 species. Pest or invasive fish (excluding trout and salmon) species present. Stream channel and morphology typically modified (e.g., channelised). Stream banks often highly modified or managed and maybe highly engineered and/or evidence of significant erosion. Riparian vegetation typically without a well-established closed canopy. Habitat highly modified.

Factors to consider in scoring sites terrestrial values in relation to species representativeness, rarity, diversity and pattern, and ecological context (adapted from EIANZ, 2018).

Value	Species Values	Vegetation/Habitat Values
Very High	Nationally Threatened - Endangered, Critical or Vulnerable.	Supporting more than one national priority type. Nationally Threatened species found or likely to occur there, either permanently or occasionally.
High	Nationally At Risk - Declining,	Supporting one national priority type or naturally uncommon ecosystem and/or a designated significant ecological area in a regional or district Plan. At Risk - Declining species found or likely to occur there, either permanently or occasionally.
Moderate-high	Nationally At Risk - Recovering, Relict or Naturally Uncommon.	A site that meets ecological significance criteria as set out the relevant regional or district policies and plans.
Moderate	Not Nationally Threatened or At Risk, but locally uncommon or rare	A site that does not meet ecological significance criteria but that contributes to local ecosystem services (e.g. water quality or erosion control).
Low	Not Threatened Nationally, common locally	Nationally or locally common with a low or negligible contribution to local ecosystem services.

Criteria for describing the magnitude of effect (adapted from EIANZ, 2018).

Magnitude	**Description**
Very High	Total loss of, or very major alteration to, key elements/features/ of the existing baseline[1] conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element/feature
High	Major loss or major alteration to key elements/features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element/feature
Moderate-high	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element/feature
Moderate	Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; AND/OR Having a minor effect on the known population or range of the element/feature
Low	Very slight change from the existing baseline condition. Change barely distinguishable, approximating the 'no change' situation; AND/OR Having negligible effect on the known population or range of the element/feature

[1] Baseline conditions are defined as 'the conditions that would pertain in the absence of a proposed action' (Roper-Lindsay et al., 2018).

Timescale for duration of effect (adapted from EIANZ, 2018).

Timescale	**Description**
Permanent	Effects continuing for an undefined time beyond the span of one human generation (taken as approximately 25 years)
Long-term	Where there is likely to be substantial improvement after a 25 year period (e.g. the replacement of mature trees by young trees that need > 25 years to reach maturity, or restoration of ground after removal of a development) the effect can be termed 'long term'
Temporary[1]	• Long term (15-25 years or longer – see above) • Medium term (5-15 years) • Short term (up to 5 years) • Construction phase (days or months)

[1]Note that in the context of some planning documents, 'temporary' can have a defined timeframe.

Criteria for describing overall levels of ecological effects (adapted from EIANZ, 2018).

	Ecological value				
Magnitude	**Very high**	**High**	**Moderate**	**Low**	**Negligible**
Very high	Very high	Very high	High	Moderate	Low
High	Very high	Very high	Moderate	Low	Very low
Moderate	High	High	Moderate	Low	Very low
Low	Moderate	Low	Low	Very low	Very low
Negligible	Low	Very low	Very low	Very low	Very low
Positive	Net gain	Net gain	Net gain	Net gain	Net gain

Interpretation of assessed ecological effects against standard RMA terms (adapted from EIANZ, 2018).

Level of ecological effect	**RMA interpretation**	**Description**
Very high	Unacceptable adverse effects	Extensive adverse effects that cannot be avoided, remedied or mitigated.
High	Significant adverse effects that could be remedied or mitigated	Adverse effects that are noticeable and will have a serious adverse impact on the environment but could potentially be mitigated or remedied.
Moderate	More than minor adverse effects	Adverse effects that are noticeable and may cause an adverse impact on the environment, but could be potentially mitigated or remedied.
Low	Minor adverse effects	Adverse effects that are noticeable but that will not cause any significant adverse impacts.
Very low	Less than minor adverse effects	Adverse effects that are discernible from day to day effects but which are too small to adversely affect the environment.
Nil	Nil effects	No effects at all.

Appendix C Photographs of streams for SEV score estimations

SEV 1 (Te Ruaotehauhau Stream under riparian canopy – permanent stream)

SEV 2 (Te Ruaotehauhau Stream without riparian margins – permanent stream)

SEV 3 (Tributary 2 – intermittent stream)

Appendix D Macroinvertebrate sample results

		Te Ruaotehauhau stream	Tributary 1	Waitaia stream
Mayfly	Atalophlebioides		9	
Mayfly	Austroclima		1	5
Mayfly	Coloburiscus	2	59	1
Mayfly	Deleatidium		1	1
Mayfly	Neozephlebia	24	14	1
Mayfly	Zephlebia	24	72	2
Stonefly	Acroperla		5	1
Caddisfly	Hydrobiosella	20		
Caddisfly	Hydrobiosis		1	
Caddisfly	Oeconesidae			2
Caddisfly	Orthopsyche	1	2	
Caddisfly	Plectrocnemia		1	1
Caddisfly	Polyplectropus	4		1
Caddisfly	Psilochorema		4	
Caddisfly	Pycnocentria	1		
Dobsonfly	Archichauliodes		3	1
Beetle	Hydrophilidae	1		1
Beetle	Ptilodactylidae	1	2	
Beetle	Scirtidae	1		
True fly	Austrosimulium	15	2	1
True fly	Dolichopididae		1	
True fly	Hexatomini	3	2	
True fly	Orthocladiinae	2	1	
True fly	Polypedilum	4	1	
True fly	Psychodidae	1	1	
True fly	Syrphidae	1		
True fly	Tanypodinae	5	1	3
True fly	Tanytarsini	1		
Collembola		4	5	7
Crustacea	Isopoda	2	5	4
Crustacea	Ostracoda	2		
Crustacea	Paraleptamphopus	46		1
Crustacea	Paranephrops	1		
Crustacea	Talitridae	1	1	2
Water mite		4	1	1
Spider	Dolomedes	1	2	2
Mollusc	Latia			1
Mollusc	Potamopyrgus	3		73
OLIGOCHAETES		5	3	5
LEECHES				2
NEMERTEANS		2		2

Appendix E SEV modelling assumptions

Function Category	Variable	ID: SEV2 Stream ID: Te Ruaotehauhau stream (without riparian margin - permanent) SEV: SEVm-P Offset: max 20 m riparian margin enhancement on both banks	ID: SEV3 Stream ID: Tributary 2 (intermittent) SEV: SEVm-P Offset: max 20 m riparian margin enhancement on both banks
Hydraulic	**Vchann**	Assumes no change to stream channel – no instream enhancement.	Assumes improvements to channel from reduction of excessive roughness elements.
	Vlining	Assumes slight reduction in fine silt from riparian margin.	Assumes reduction in fine silt from riparian margin.
	Vpipe	Assumes no pipe.	Assumes one pipe.
	Vbank	Assumes no change to current bank conditions.	Assumes no change to current bank conditions.
	Vrough	Assumes dominated by native regenerating vegetation in late stage of succession, some low diversity regenerating and stock exclusion and remnant mature exotic trees (to 20 m on each bank).	Assumes dominated by native regenerating vegetation in late stage of succession, some low diversity regenerating and stock exclusion and remnant mature exotic trees (to 20 m on each bank).
	Vbarr	Assumes no change to current with no physical barriers.	Assumes no change to current with no physical barriers.
	Vchanshape	Autopopulated.	Autopopulated.
Biogeochemical	**Vshade**	Assumes very high, high, and moderate shading from 20 m riparian margin enhancement along entire length.	Assumes very high, high, and moderate shading from 20 m riparian margin enhancement along entire length.
	Vdod	Assumes no change to current optimal.	Assumes no change to current sub-optimal.
	Vveloc	Assumes no change to estimated fast flow observed during site.	Assumes no change to estimated gentle flow observed during site.
	Vdepth	Assumes no change to estimated depth observed during site.	Assumes no change to estimated depth observed during site.
	Vripar	Assumes a full 20 m riparian margin.	Assumes a full 20 m riparian margin.
	Vdecid	Assumes no change from no deciduous (no deciduous observed on site).	Assumes no change from no deciduous (no deciduous observed on site).
	Vmacro	Assumes no change to no macrophytes observed.	Assumes reduction in macrophytes following shading and planting.
	Vretain	Autopopulated.	Autopopulated.
	Vsurf	Assumes slight increase in woody debris.	Assumes slight increase in woody debris and leaf litter input.
	Vripfilt	Assumes slight improvement to filtering following planting.	Assumes slight improvement to filtering following planting.
Habitat Provision	**Vgalspwn**	Assumes no change to existing gradients.	Assumes no change to existing gradients.
	Vgalqual	Assumes high quality following planting.	Assumes high quality following planting.
	Vgobspawn	Autopopulated.	Autopopulated.

	Vphyshab	Assumes slight increase in aquatic habitat diversity including wood, undercut banks, and rooted aquatic vegetation that are evenly distributed along reach. Assumes no changes to existing hydrological heterogeneity. Assume very high channel shade and vegetation integrity with 20 m planting on both banks.	Assumes slight increase in aquatic habitat diversity including wood, undercut banks, and rooted aquatic vegetation that are evenly distributed along reach. Assumes slight changes to existing hydrological heterogeneity. Assume very high channel shade and vegetation integrity with 20 m planting each bank.
	Vwatqual	No change from minimal due to similar landuse in catchment above site.	No change from minimal due to similar landuse in catchment above site.
	Vimperv	Assumes no change to existing <10% impervious above site.	Assumes no change to existing <10% impervious above site.
Biodiversity	**Vfish**	-	-
	Vmci	-	-
	Vept	-	-
	Vinvert	-	-
	Vripcond	Autopopulated.	Autopopulated.
	Vripconn	Assumes no change to current not impeded connection.	Assumes no change to current not impeded connection.

Appendix F Plant species list

Table 1: Vascular plant species list developed from site walkover. * indicates species was observed outside but close to the Project footpritn

Common name	Species name	Threat classification
Wattle	*Acacia spp.*	Introduced
Hanging spleenwort	*Asplenium flaccidum*	Not Threatened
Shining spleenwort	*Asplenium oblongifolium*	Not Threatened
Tank lily	*Astelia hatatum*	Not Threatened
Perching lily	*Astelia solandri*	Not Threatened
Taraire	*Beilschmieidia tawa*	Not Threatened
Rautahi	*Carex geminata*	Not Threatened
Marbleleaf	*Carpodetus serratus*	Not Threatened
Taro	*Colocasia esculenta*	Introduce/Culturally important
Large-leaved coprosma	*Coprosma grandifolia*	Not Threatened
Karaka	*Corynocarpus laevigatus*	Not Threatened
Silver fern	*Cyathea dealbata*	Not Threatened
Mamaku	*Cyathea medullaris*	Not Threatened
Kahikatea	*Dacrydium dacrydioides*	Not Threatened
German ivy	*Delairea odorata*	Introduced
Whekī	*Dicksonia squarrosa*	Not Threatened
Rasp fern	*Doodia australis*	Not Threatened
Kohekohe	*Dysoxylum spectabile*	Not Threatened
Parataniwha	*Elatostema rugosum*	Not Threatened
Kutakuta	*Eleocharis sphacelata*	Not Threatened
Eucalyptus	*Eucalyptus spp.*	Not Threatened
Kōtukutuku	*Fuchsia excortica*	Not Threatened
Wild ginger	*Hedychium gardnerianum*	Not Threatened
Pigeonwood	*Hedycarya arborea*	Not Threatened
Thread fern	*Icaris filiformis*	Not Threatened
Soft rush	*Juncus effusus*	Not Threatened
Rewarewa	*Knighta excelsa*	Not Threatened
Kānuka	*Kunzea robusta*	Threatened - Nationally Vulnerable
Mānuka	*Leptospermum scoparium*	At Risk - Declining
Ox-eye daisy	*Leucantheum vulgare*	Introduced
Mahoe	*Melicytus ramiflorus*	Not Threatened
White rātā	*Metrosideros diffusa*	Threatened - Nationally Vulnerable
Akatea	*Metrosideros perforata*	Threatened - Nationally Vulnerable
Large-leaved pohuehue	*Muehlenbeckia australis*	Not Threatened
Mapou	*Myrsine australis*	Not Threatened
Basket grass	*Oplismenus hertillus subsp. Imbicillus*	Not Threatened
Ring fern	*Paesia scaberula*	Not Threatened
Kiokio	*Parablechnum novaezelandiae*	Not Threatened

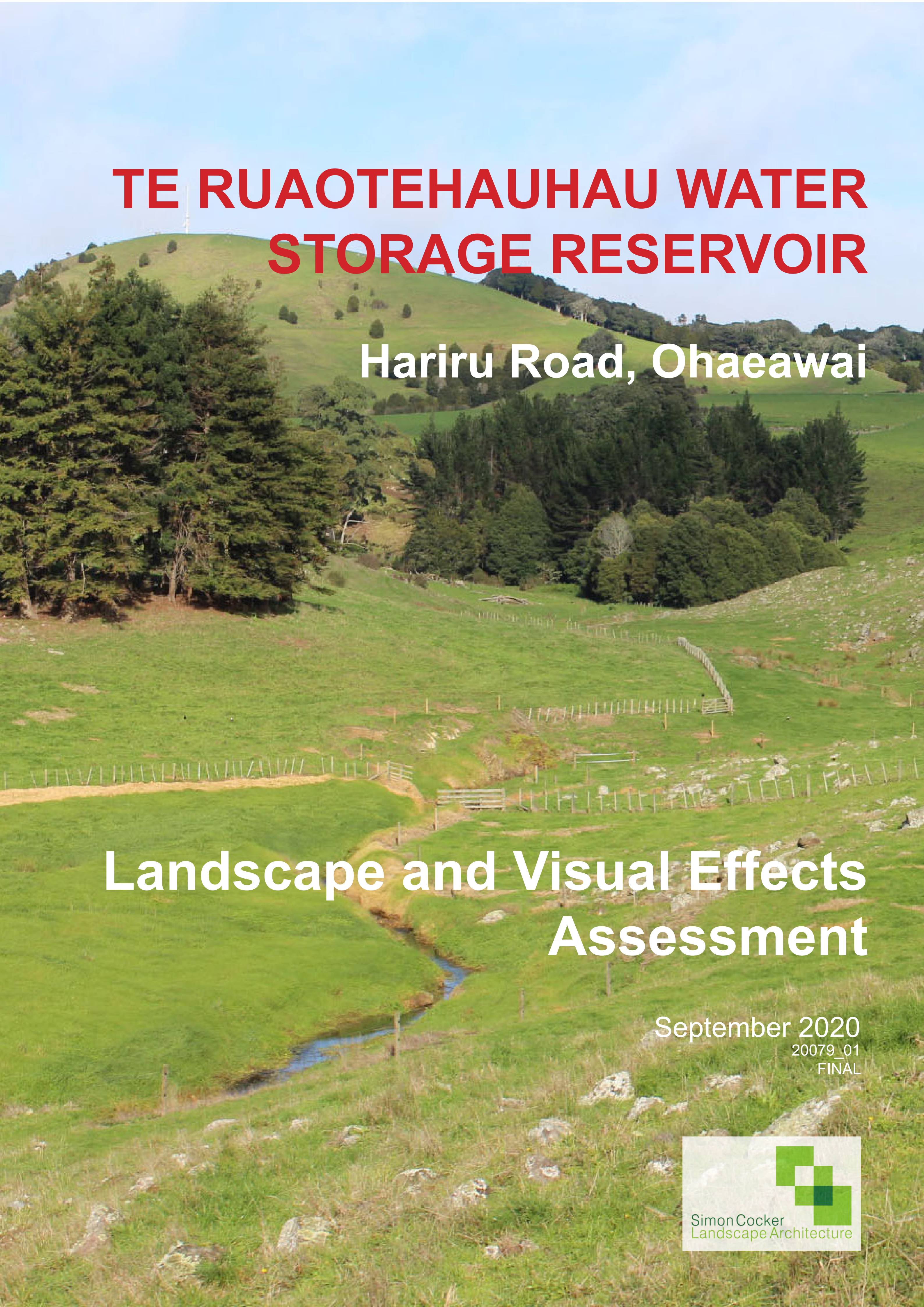
Swamp kiokio	*Parablechnum minus*	Not Threatened
Smooth shield fern	*Parapolystichum glabellum*	Not Threatened
NZ passionfruit	*Passiflora tetrandra*	Not Threatened
New Zealand flax	*Phormium tenax*	Not Threatened
Pine	*Pinus radiata*	Introduced
Kawakawa	*Piper excelsum*	Not Threatened
Tawhirikaro*	*Pittosporum cornifolium**	Not Threatened*
Gully fern	*Pneumatopteris pennigera*	Not Threatened
Tōtara	*Podocarpus totara*	Not Threatened
Nīkau	*Rhopalostylis sapida*	Not Threatened
Supplejack	*Ripogonum scandens*	Not Threatened
Pate	*Schefflera digitata*	Not Threatened
Redwood	*Sequoia sempervirens*	Introduced
Woolly nightshade	*Solanum mauritianum*	Introduced
Swamp maire	*Syzigium maire*	Threatened - Nationally Critical
Tradescantia	*Tradescantia flumenensis*	Introduced
Purīrī	*Vitex lucens*	Not Threatened
Towai	*Weinmannia sylvicola*	Not Threatened

Appendix G Site visit photographs

 Photograph 1: Tōtara treeland	 Photograph 2: Secondary broadleaf forest with old-growth signatures
 Photograph 3: Taraire and pūriri amongst pine forest on Trib 2	 Photograph 4: Tank lily within swamp forest
 Photograph 5: Pūriri forest remnants	 Photograph 6: Volcanic boulderfield next to secondary broadleaf forest with occasional exotic redwood

 Photograph 7: Row of mature pine trees	 Photograph 8: Small kutakuta wetland surrounded by exotic forest

Appendix G. Landscape and Visual Amenity Assessment Report



TE RUAOTEHAUHAU WATER STORAGE RESERVOIR

Hariru Road, Ohaeawai

Landscape and Visual Effects Assessment

September 2020
20079_01
FINAL

Simon Cocker
Landscape Architecture

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1.0 INTRODUCTION

Te Tai Tokerau Water Trust Board ('the applicant') have received provincial growth funding to provide improved water supply in Northland. Williamson Water and Land Advisory (WWLA) is leading the provision of a range of technical services to inform the project. Simon Cocker Landscape Architecture (SCLA) has been engaged to prepare this assessment of landscape and visual amenity effects associated with a proposed water supply reservoir (Te Ruaotehauhau Stream Water Supply Reservoir) off Hariru Road, Ohaeawai, in the Far North District.

In brief, the applicant proposes to construct a new water supply reservoir, by constructing a dam across the Te Ruaotehauhau Stream, and inundating a section of the Ruaotehauhau Stream, including headwaters, and surrounding land (Figure 1 in Appendix 1). The proposed reservoir will have a 21.0m high embankment and a storage volume of 1,400,000 cubic metre (m^3) (at full supply level).

It is the opinion of the author that the proposal is appropriate from a landscape and visual perspective.

2.0 ASSESSMENT METHODOLOGY

The assessment has been prepared by a Registered Landscape Architect with reference to the Quality Planning Landscape Guidance Note 1 and its signposts to examples of best practice, which include:

- Best Practice Note 10.1, Landscape Assessment and Sustainable Management, New Zealand Institute of Landscape Architects (2010).
- Guidelines for Landscape and Visual Impact Assessment 3rd Edition, Landscape Institute (UK) and IEMA (2013).
- Information Requirements for the assessment of Landscape and Visual Effects, Auckland Council (2017).

In addition, this report has been prepared in accordance with the NZILA (New Zealand Institute of Landscape Architects) Code of Conduct[1].

Effects Ratings and Definitions

An outline of the effects ratings and definitions used in this assessment is provided in Appendix 2 – Landscape and Visual Assessment Methodology. In summary, the significance of effects identified in this assessment are based on a seven-point scale which includes very low; low; moderate – low; moderate, moderate – high, high, and very high. A rating of moderate to low equates to minor in terms of RMA terminology.

Desktop study and site visits

In conducting this assessment, a desktop study was completed which included a review of the relevant information relating to the landscape and visual aspects of the project. This information included:

- Northland Regional Policy Statement (2016);
- The Far North District Plan;
- Geotechnical and site suitability assessment MN06 water storage reservoir, Ohaeawai, prepared by Riley Consultants Ltd., dated 14 August 2020;
- Hydrology Assessment prepared by Williamson Water and Land Advisory, dated 10 March 2020;

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[1] Contained in Appendix 1 of: http://www.nzila.co.nz/media/50906/registered_membership_guide_final.pdf

- Archaeological assessment of the proposed MN06 Water Storage Reservoir, prepared by Geometria Limited, 24 August 2020;
- Te Ruatehauhau Stream Water Storage Reservoir. Assessment of Ecological Effects, prepared by Puhoi Stour dated 28 August 2020;
- Cultural Impact Assessment, prepared by xxxxxx, and dated xxxxxxx;
- Topographical survey plans, and;
- Aerial photography, Far North District Council GIS mapping, Google Earth and Streetview

Two site visits were undertaken. The first on 10 June 2020, and the second on 13 July 2020.

3.0 THE PROPOSAL

The proposal is shown on Figures 2a, and 2b in Appendix 1. The proposed reservoir, when the water level is at the full supply level will store a volume of approximately 1,400,000m^3. The proposal is described in detail in the application and comprises the following elements of relevance to this assessment:

Vegetation clearance

The total quantity of indigenous vegetation loss is 1.46 ha, with an additional 0.75 ha of volcanic boulderfield, 1.32 ha of exotic forest and 0.22 ha of wet pasture removal.

Embankments, Excavation and filling

The dam embankment will approximately 21.0m high in the main valley section and around 400m long. Only the central portion (~50m in length) is in the order of 10m to 20m high, with majority of its length on the left abutment – which extends some 300m to the north west – being generally less than 5m or 10m.

The embankment will have up- and down-stream slope batters of 1V:3H (horizontal : vertical) and 1V:2H with a 5m wide mid-height bench, and 5m wide crest. There is potential for the down-stream slope batter of the left hand embankment to be 'eased' to a more gentle slope so that its integrates more effectively with the contextual topography.

A low-level conduit installed within the valley floor at the toe of the left abutment would provide temporary flood diversion during construction, and house both a residual flow pipe and supply pipes. A flood spillway is envisaged to be formed beyond the right abutment, discharging to the stream approximately 200m below the dam.

The embankment will comprise a riprap facing on the upstream side of the 3H:1V embankment slope to prevent erosion of the dam face, and the downstream dam face will be maintained in grass.

No material is intended to be exported from the site, and only a small amount of specialist filter aggregate and riprap imported for the dam embankment and reservoir formation.

Overall, it is understood that the total volume of earthworks will be 255,480m^3. This will comprise the following:

• Spillway cut	92,610 m^3
• Foundation cut	19,600 m^3 (Strip 500mm generally, 3m key in central section)
• Dam embankment fill	143,270 m^3 (includes backfilling stripped & key excavation)

As illustrated on Figure 2b, potential borrow sites have been identified on the spurs to the south west of the reservoir. It is recommended that, where material is excavated for use in the dam construction, that the final landform be shaped to reflect, and integrate with the adjoining unmodified landform. These areas shall be covered with topsoil and regrassed for grazing, or planted with trees, or native revegetation.

Landscape and visual mitigation

Opportunities exist for the revegetation of the riparian margins of the reservoir, particularly where watercourses flowing into the storage area provide opportunities for riparian plantings and / or linking existing pockets of wetland and remnant forest fragments. This element of the proposal will be developed in conjunction with the ecologist and with land owners. With regard to the latter, it is understood that the various landowners have a range of perspectives on the use of land bordering the future reservoir. A setback will however, be required to prevent stock from affecting water quality. Preferably, this riparian set back will be planted with native species, so that in the longer term, the need for ongoing management and weed control. Where possible, the landscape mitigation planting will be undertaken so that it also functions as a part of the ecological terrestrial offset and compensation package.[2]

The revegetation planting depicted in Figure 2c provides an indicative illustration of how such revegetation planting could occur. The suggested areas of revegetation respond to the hydrological and landscape patterns, seeking to enhance the landscape values of these existing features, and the reservoir as proposed, as well as taking into consideration the desire to provide screening of the reservoir and associated earthworks from the wider environment. The plant palette and mixes will reflect locally occurring ecosystem types and species. Plant material will be sourced locally.

It is also intended that the areas of proposed revegetation will assist with the integration of the reservoir into the landscape when viewed from locations such as Hariru Road and properties to the north. The plantings will reflect the landform, reinforcing the natural patterns and thereby enhancing the 'natural' appearance of the reservoir.

In addition, the areas of revegetation will fragment views of the reservoir so that the more 'artificial' elements – such as the linear form of the embankment which extends to the north west from the dam structure – will be softened and their 'artificiality' masked.

Another feature of the reservoir that has the potential to detract from its natural appearance is the fluctuation in water levels during periods of increased water use. Where dry periods extend over several winter and summers, this may result in the 'draw-down' largely draining the reservoir. The usual draw-down range will however, be less dramatic, but fluctuations will result in the revealing of a 'tide mark' around the reservoir margin as the water level falls.

Whilst riparian plantings around the reservoir margins will serve to mask the 'tide mark' to some extent, it is also recommended that rock 'won' during construction be placed within the 'zone of fluctuation', and on the riparian margins of the reservoir. Scattered rock within areas of pasture is a feature of the landscape, and this measure will assist with reducing the visual contrast when water levels fluctuate. In addition, as is described in the ecological report[3] that such rock-fields also have the potential to provide ecological benefits.

It is recommended that the mitigation planting proposal will be refined in conjunction with the project ecologist. Quantify the amount of vegetation and wetland enhancement required to offset the effects of the reservoir. This will require further exploration of suitable offset sites near to the proposed reservoir, and identification of a potential compensation site for swamp forest loss. Furthermore, it is recommended that ecological terrestrial offset compensation package / restoration management plan include consideration of landscape and visual mitigation in its development, or that a standalone

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[2] Puhoi Stour. *Te Ruatehauhau Stream Water Storage Reservoir. Assessment of Ecological Effects*, 28 August 2020. Section 5.2

[3] Ibid. Section 5.2

Landscape and Visual Mitigation Plan be required as a condition of consent. This plan should be consistent with any ecological management plans required by the consent.

4.0 EXISTING ENVIRONMENT

4.1 Location and land ownership

The subject site is located within a property identified as Lot 2 DP 442506, Sec 16S Remuera SETT, Sec 12S Remuera SETT, Lot 3 DP 97908 and Okokako and is located approximately 2.0km to the west of Ohaeawai.

4.2 Topography, geology and soils of the site and its context

The landscape of the area is characterised by its volcanic origins, with volcanic cones forming focal features. These also have strong associations with the cultural heritage of the area, conveyed by pa site formations on many of the prominent cones.

Basalt scoria cones and extensive basalt flows and shields have erupted in this area over the last 10 million years. Although the older (pre 2 Ma) cones have disappeared, eroded remnants of the flows now form upstanding plateaux, extending from Okaihau to Kerikeri and north to Whangaroa. Deep, subtropical weathering of these features has produced the rich volcanic soils that nurture Kerikeri's orchards and crops.

In the last half-million years, 12 small basalt volcanoes have erupted in the southern part of the field, forming a cluster of scoria cones around Kaikohe. The youngest volcano is Tauanui, 10 km south of Kaikohe, which 60,000 years ago produced a high scoria cone and a lava flow that flowed 19 km down the Taheke Valley towards the Hokianga Harbour. The field includes a number of small rhyolite domes (Putahi, 381m, Tarahi, 388m and Haruru, 350m), overlooking Lake Omapere. It is understood that the field is considered dormant, and not extinct.

As is illustrated in Plate 1 below, the Kaikohe volcanic centre is marked by a scoria cone at Memorial Hill that reaches an elevation of 282 m and is approximately 1 km in diameter. The basalt flows associated with the Kaikohe volcanic centre, defined as the Kaikohe Basalt, extend to the south and south-east of the cone splitting into two main lobes. One lobe extends south-west along State Highway 12 and the other extends south along Mangakahia Road to the Punakitere River. These lobes appear to follow pre-existing valleys.

The Kaikohe Basalt slopes from north to south, falling from an elevation of approximately 200m near the base of the scoria cone to 160 m near the southern limit of the basalt. Most of the Kaikohe Basalt ranges between 180m and 160m with steeply sloping edges.

The geotechnical assessment[4] described the site as being underlain by basalt lava flows and occupies a volcanic plateau formed by lava flows inferred to originate from three prominent scoria cones: Tarahi Volcano to the south (refer to photo 1), Maungakawakawa to the south-west (refer to photo 2), and Te Ahuahu to the north-west (refer to photo 3). More specifically, the site is located on the lower northern slopes of the Tarahi volcano, which forms the highest scoria cone in the Kaikohe Volcanic Field, approximately 140m above the surrounding flows. The lava flows to the east and

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[4] Riley Consultants. *Geotechnical and site suitability assessment MN06 water storage reservoir, Ohaeawai* 14 August 2020. Section 4.0

north east of this feature form a series of spurs which project into the site (refer to Figure 1), whilst further to the north and east, beyond the extent of the lava flows, the landform assumed a more gently undulating character.

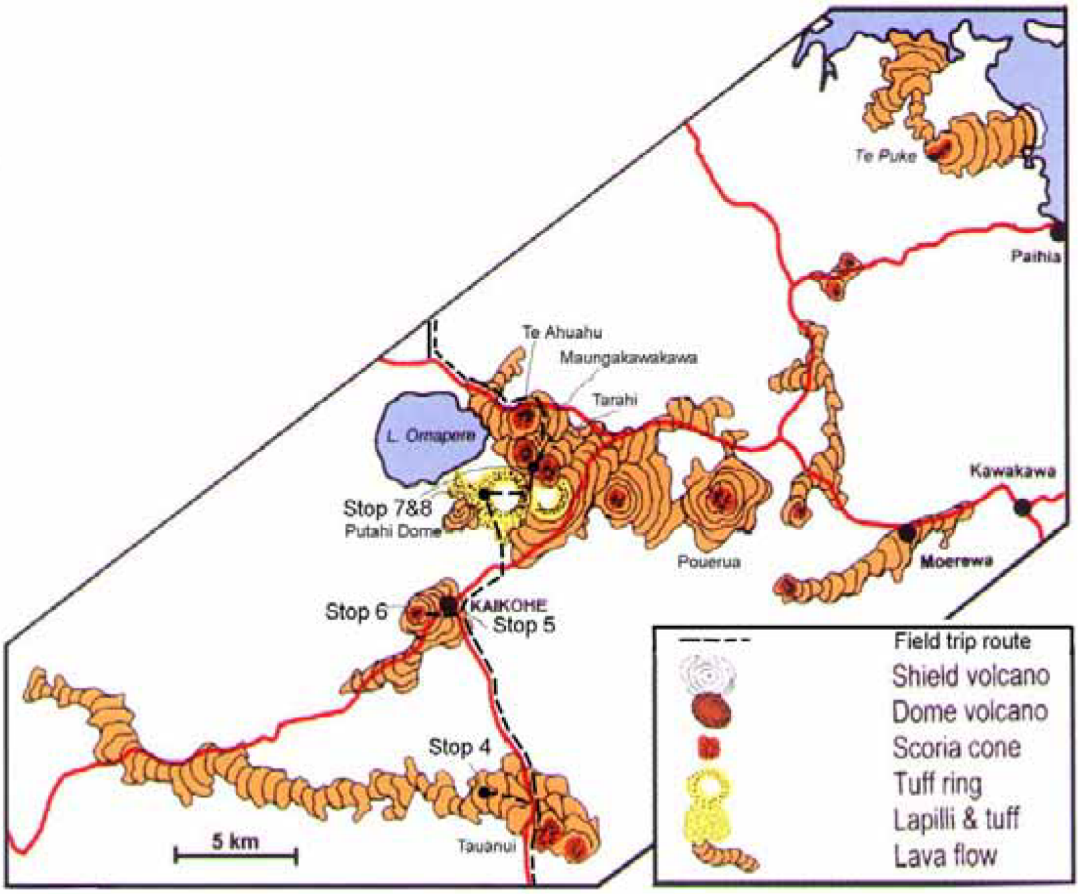

Plate 1: Map of the Kaikohe Basaltic Volcanic Field (Hayward 2002, after Mulheim 1973)

The Maungakawakawa volcano to the west forms a 60m high scoria cone that breached to the north-west and formed radially running volcanic flows. The Te Ahuahu volcano forms a prominent scoria cone rising 100m above its east-west trending flows below.

The topography falls gradually to the south east, and from Hariru Road, long views are possible across the landscape in this direction (refer to photo 4)

The geotechnical report notes that the overlying soil types for the Whangaroa-Kaikohe area are underlain by Waiotu friable clay towards the northern side of the site, Whakapai friable clay loam to the south, Ruatangata friable clay towards the west and likely Otaha clay further to the west of the site.

4.3 Hydrology of the site and its context

The site is contained within the catchment of the Te Ruaotehauhau Stream which flows to the east to join the Pekapeka Stream some 500m to the south of Ohaeawai. The Pekapeka Stream subsequently discharges into the Waiaruhe River, and subsequently into the Waitangi River.

The catchment boundary of the Te Ruaotehauhau Stream is defined by the ridge which links Te Ahuahu, Maungakawakawa and Tarahi and is traced by Hariru Road.

4.4 Vegetation of the site and its context

Photos 1 – 4 illustrate how the wider context of the site is primarily under pasture and is grazed. Within the site this consists of pasture grass, pugged and wet pasture.

Pockets of native forest, and groves of trees are in evidence. Often these are associated with less productive grazing land, such as steeper slopes, as fingers of riparian vegetation within gullys, or on the flatter, low-lying and wet areas of pasture. With respect to the latter, remnants of swamp forest are a characterising feature of the area. Exotic vegetation, including pine plantations, shelterbelts and barberry hedges also lend structure and impart a impression of a productive landscape.

Whilst only seen as occasional features within the Te Ruaotehauhau basin, shelterbelts are more prevalent to the west, to the north, to the north east and to the east of the site, reflecting those areas where soils are suitable for horticultural production.

The ecological report describes a number of iindigenous terrestrial ecosystem types within the vicinity of the Site[5], these include:

- Pūriri forest on basalt volcanic substrate;
- Riparian swamp forest;
- Secondary broadleaf forest with old-growth remnants, and;
- Tōtara treeland.

The documents states that:

Stock have access to areas of pasture grass and some areas of indigenous vegetation, however much of the indigenous vegetation is fenced from stock and therefore in good ecological condition.

A small area of grazed rautahi (Carex secta) is present as riparian wetland along the Te Ruaotehauhau Stream margin, and kutakuta wetland (Eleocharis sphacelata) is present on the margin of a farm pond in the south-western corner of the proposed reservoir. Wetlands, regardless of ecological condition, are a nationally threatened ecosystem type, with 10% of the original wetland extent remaining nationally.

4.5 Land use of the site and its context

As described above, the primary land use through the environs of the site is pastoral grazing, although pockets of horticultural production are signaled by shelterbelts along State Highway 1 to the east and to the west, between Hariru Road and Lake Omapere.

The township of Ohaeawai forms a cluster of settlement some 2.0km to the east, whilst rural residential properties of between 1.0ha and 10ha in area are aligned along State Highway 1 and State Highway 12 to the east, south east and south..

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[5] Ibid Section 5.1

In the vicinity of the site, the majority of properties are in larger landholdings, although some smaller properties between 5,000 – 1.5ha in area are scattered along Hariru and Remuera Settlement Road. Scattered clusters of settlement are observed at the northern end of Hariru Road (near the junction with the State Highway) and along an elevated section of Hariru Road on the eastern side of Maungakawakawa. This latter linear cluster extends south along the road toward its junction with Remuera Settlement Road.

Recent subdivision of rural residential properties is in evidence on Hariru Road (Sec 12S Remuera SETT).

4.6 Visual catchment and extent of visibility

The visual catchment of the site encompasses a relatively limited areas. To the north west, west, south west and south it is contained by landform, this being the volcanic features of Te Ahuahu, Hariru, Tarahi and the catchment boundary ridge linking these three features (refer to Figure 3).

The linking ridge is traced by Hariru Road, and intermittent glimpses into the valley are possible, although north easterly and easterly trending spurs frequently interrupt views. A number of dwellings are located on Hariru Road and offer long views over the landscape to the north east and east.

To the north and north east the landform is gently undulating, and whilst there is the potential for more extensive views from these directions, vegetation including shelterbelts screens the site from State Highway 1.

4.6.1 Viewing audiences

Public viewing audiences

- Road users and pedestrians on Hariru Road

Private Viewing audiences

- Occupants of dwellings located to the north west of the site (within Lot 1 DP 442506, Sec 5S Remuera SETT,
- Occupants of dwellings located to the west of the site (within Lot 1 DP 378424, Sec 50S Remuera SETT, Lot 1 DP 157098, Pt Hariru B and Poukai A, Sec 58S Remuera SETT, and Lot 1 DP 322598)

4.7 Statutory context

This section provides a brief statutory assessment against the matters set out in section 104(1) of the Resource Management Act 1991 (RMA) and other relevant planning documents with regards to the proposed works, including:

- Part 2 of the RMA
- Northland Regional Policy Statement
- Far North District Plan

4.7.1 Resource Management Act 1991

Part 2 of the Act requires that the proposed activity must meet the purpose of the Act as outlined in Section 5 “to promote the sustainable management of natural and physical resources.”

Section 6 of the Act identifies 8 matters of national importance to be had regard to in achieving the purposes of the Act. The following are of relevance to the proposal:

- The preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development

Section 7 of the Act identifies 11 other matters to be had regard to in achieving the purposes of the Act. The following are of relevance to the proposal:

- The maintenance and enhancement of amenity values; and
- intrinsic values of ecosystems; and
- the maintenance and enhancement of the quality of the environment.

4.7.3 Northland Regional Policy Statement (2016)

A number of Outstanding Natural Features located within the vicinity of the site are identified in the Northland Regional Policy Statement. This includes the the Maungakawakawa Scoria Cone, the Tarahi Scoria Cone, the Te Ahuahu Volcanic Cone, the Maungaturoto Volcanic Cone, Waimitimiti Scoria Mounds, Te Pua Crater and Flows and Lake Omapere.

3.14 Natural character, outstanding natural features, outstanding natural landscapes and historic heritage.

Identify and protect from inappropriate subdivision, use and development;

(a) The qualities and characteristics that make up the natural character of the coastal environment, and the natural character of freshwater bodies and their margins;
(b) The qualities and characteristics that make up outstanding natural features and outstanding natural landscapes;
(c) The integrity of historic heritage.

4.6 Managing effects on natural character, features / landscapes and heritage

(1) ……….

(2) Outside the coastal environment avoid significant adverse effects and avoid, remedy or mitigate other adverse effects (including cumulative adverse effects) of subdivision, use and development on the characteristics and qualities of outstanding natural features and outstanding natural landscapes and the natural character of freshwater bodies. Methods which may achieve this include:

a) *In outstanding natural landscapes, requiring that the location and intensity of subdivision, use and built development is appropriate having regard to, natural elements, landforms and processes, including vegetation patterns, ridgelines and freshwater bodies and their margins;*
b) *In outstanding natural features, requiring that the scale and intensity of earthworks and built development is appropriate taking into account the scale, form and vulnerability to modification of the feature;*
c) *Minimising, indigenous vegetation clearance and modification (including earthworks / disturbance and structures) to natural wetlands, the beds of lakes, rivers and their margins.*

(3) When considering whether there are any adverse effects on the characteristics and qualities of the natural character, natural features and landscape values in terms of (1)(a), whether there are any significant adverse effects and the scale of any adverse effects in terms of (1)(b) and (2), and in determining the character, intensity and scale of the adverse effects:

a) *Recognise that a minor or transitory effect may not be an adverse effect;*

b) *Recognise that many areas contain ongoing use and development that:*

  ii. *Were present when the area was identified as high or outstanding*
  iii. *or have subsequently been lawfully established*
  iv. *May be dynamic, diverse or seasonal;*

c) *Recognise that there may be more than minor cumulative adverse effects from minor or transitory adverse effects; and*

d) *Have regard to any restoration and enhancement on the characteristics and qualities of that area of natural character, natural features and/or natural landscape.*

4.7.4 Far North District Plan

The objectives and policies of relevance to this assessment are as follows:

8.3.1 To promote the sustainable management of natural and physical resources of the rural environment.

8.3.3 To avoid, remedy or mitigate the adverse and cumulative effects of activities on the rural environment.

8.3.4 To protect areas of significant indigenous vegetation and significant habitats of indigenous fauna.

8.3.5 To protect outstanding natural features and landscapes.

8.3.7 To promote the maintenance and enhancement of amenity values of the rural environment to a level that is consistent with the productive intent of the zone.

8.4.2 That activities be allowed to establish within the rural environment to the extent that any adverse effects of these activities are able to be avoided, remedied or mitigated and as a result the life supporting capacity of soils and ecosystems is safeguarded and rural productive activities are able to continue.

8.4.3 That any new infrastructure for development in rural areas be designed and operated in a way that safeguards the life supporting capacity of air, water, soil and ecosystems while protecting areas of significant indigenous vegetation and significant habitats of indigenous fauna, outstanding natural features and landscapes.

8.4.4 That development which will maintain or enhance the amenity value of the rural environment and outstanding natural features and outstanding landscapes be enabled to locate in the rural environment.

8.4.6 That areas of significant indigenous vegetation and significant habitats of indigenous fauna habitat be protected as an integral part of managing the use, development and protection of the natural and physical resources of the rural environment.

8.4.8 That, when considering subdivision, use and development in the rural environment, the Council will have particular regard to ensuring that its intensity, scale and type is controlled to ensure that adverse effects on habitats (including freshwater habitats), outstanding natural features and landscapes on the amenity value of the rural environment, and where appropriate on natural character of the coastal environment, are avoided, *remedied or mitigated. Consideration will further be given to the functional need for the activity to be within rural environment and the potential cumulative effects of non-farming activities.*

Rural Production Zone

8.6.3.1 To promote the sustainable management of natural and physical resources in the Rural Production Zone.

8.6.3.3 To promote the maintenance and enhancement of the amenity values of the Rural Production Zone to a level that is consistent with the productive intent of the zone.

8.6.3.4 To promote the protection of significant natural values of the Rural Production Zone.

8.6.4.2 That standards be imposed to ensure that the off-site effects of activities in the Rural Production Zone are avoided, remedied or mitigated.

8.6.4.3 That land management practices that avoid, remedy or mitigate adverse effects on natural and physical resources be encouraged.

8.6.4.4 That the type, scale and intensity of development allowed shall have regard to the maintenance and enhancement of the amenity values of the Rural Production Zone to a level that is consistent with the productive intent of the zone.

12.1.2

12.1.2.1 To protect outstanding landscapes and natural features from inappropriate, subdivision use and development.

12.1.2.2 To protect the scientific and amenity values of outstanding natural features.

12.1.2.3 To recognise and provide for the distinctiveness, natural diversity and complexity of landscapes as far as practicable including the complexity found locally within landscapes and the diversity of landscapes across the District.

12.1.4 To avoid adverse effects and to encourage positive effects resulting from land use, subdivision or development in outstanding landscapes and natural features and Maori cultural values associated with landscapes.

12.1.5 That both positive and adverse effects of development on outstanding natural features and landscapes be taken into account when assessing applications for resource consent.

12.1.5 That activities avoid, remedy or mitigate significant adverse effects on both the natural and the cultural values and elements which make up the distinctive character of outstanding natural features and landscapes.

12.1.5 That the cumulative effect of changes to the character of Outstanding Landscapes be taken into account in assessing applications for resource consent.

12.1.6 That the visibility of Outstanding Landscape Features, when viewed from public places, be taken into account in assessing applications for resource consent.

12.1.7 That the adverse visual effect of built development on outstanding landscapes and ridgelines be avoided, remedied or mitigated.

12.1.8 That activities avoid or mitigate adverse effects on the scientific and amenity values associated with outstanding natural features.

12.1.9 That the diversity of outstanding landscapes at a District-wide and local level be maintained and enhanced where practicable.

12.1.10 That the trend is towards the enhancement rather than the deterioration of landscape values, including the encouragement of the restoration of degraded landscapes.

12.1.11 That the high value of indigenous vegetation to Outstanding Landscapes be taken into account when assessing applications for resource consents.

12.1.12 That landscape values be protected by encouraging development that takes in account:

> *(a) the rarity or value of the landscape and/or landscape features;*
> *(b) the visibility of the development;*
> *(c) important views as seen from public vantage points on a public road, public reserve, the foreshore and the coastal marine area;*
> *(d) the desirability of avoiding adverse effects on the elements that contribute to the distinctive character of the coastal landscapes, especially outstanding landscapes and natural features, ridges and headlands or those features that have significant amenity value;*
> *(e) the contribution of natural patterns, composition and extensive cover of indigenous vegetation to landscape values;*
> *(f) Maori cultural values associated with landscapes;*
> *(g) the importance of the activity in enabling people and communities to provide for their social, economic and cultural well-being.*

Overall it is understood that the activity status of the application is non-complying.

5.0 IDENTIFIED LANDSCAPE VALUES

The identified landscape values are depicted on Figure 4. The subject site is not subject to any landscape overlay within the Northland Regional Policy Statement, in the Kaipara District Plan or in any non-statutory documents.

5.1 Ecological values

Located some 750m to the west of the site, a number of forest remnants constitute virtually the only forest in the catchment of Lake Omapere. Identified as Remuera Settlement Road Remnants (P05/038), the remnants comprise fragmented totara, towai, taraire and puriri forest growing on the flanks of, and within the crater of Maungakawakawa.

The ecology report assesses the terrestrial ecological values as follows:

Puriri forest: Mature pūriri forest is one of Northland’s rarest ecosystem types, with 1000 ha remaining and less than 50 ha protected. Volcanic broadleaf forests (e.g. pūriri forest) has been identified as a priority area for protection24. This forest type typically supports indigenous lizards, keystone birds such as kukupa (*Hemiphaga novaeseelandiae*) and can provide habitat to native bats and kauri snails. It is therefore considered as having very high ecological value.

Riparian swamp forest: Swamp forest habitats have reduced in extent nationally due to the draining of wetlands and habitat clearance. Swamp forest is regionally under-represented with two intact examples left in the Ecological District, constituting 1.5% of natural areas left in the Ecological District. The presence of Threatened – Nationally Critical swamp maire further increases the quality and importance of this habitat……This ecosystem type is therefore considered of very high ecological value.

Secondary broadleaf forest with old growth remnants: Overall, this habitat is in good ecological condition with stock exclusion resulting in regeneration of indigenous broadleaved species among remnant mature trees. Secondary broadleaf forests provide habitat for indigenous bats, birds, lizards and kauri

snails. The relatively small extent of this ecosystem type, and predominantly regenerating nature result in this ecosystem being considered of moderate ecological value. Kānuka is considered as having very high ecological value due to its threat classification of Threatened – nationally vulnerable.

Totara treeland: No threatened or at-risk species were present in this ecosystem type, but tōtara treelands may provide habitat for native bats, birds and lizards and are therefore considered of moderate ecological value. Tōtara treelands are currently providing buffering and shading to Waitaia Stream and Te Ruaotehauhau Stream.

Volcanic boulderlands: The volcanic boulderfields are severely degraded due to stock impacts and provide little habitat to native fauna. However native skinks may utilise boulders as shelter and basking, and due to their status as endangered are therefore classified as having high ecological value.

Exotic forest: For the purposes of this assessment we have conservatively assumed that indigenous bats and North Island brown kiwi are present and therefore exotic forest is classified as having moderate ecological value.

Indigenous dominated wetlands: Given that the wetlands were of a small extent but dominated by indigenous species, both are considered as having high ecological value.

Wet pasture grass: Under the Proposed Regional Plan for Northland pasture wetlands dominated by rushes are not considered a ‘Natural Wetland’ and are therefore considered of low ecological value.

The ecological values assigned in the ecological report for bats, avifauna, herpetofauna, and invertebrates is very high, high, high and high respectively.

5.2 Landscape values

Far North Landscape Assessment

The site is contained within the Waimate / Okaihau Area landscape unit (Unit T23) as delineated in the Far North District Landscape Assessment[6]. The unit is contained within the Heritage landscapes category, and is described as having an over-riding strong heritage signature where a range of elements contribute to contribute to the sense of history. This includes evidence of Maori and European heritage, conveyed by pa site formations on volcanic cones, and the prevalence of historic buildings, stone walls and thorn hedges.

The assessment notes the contribution of vegetation to the landscape character – groves of mature indigenous vegetation, as well as mature exotic trees associated with the historic homesteads.

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[6] LA4 Landscape Architects. *Far North District Landscape Assessment*. 1995. P.32.

The assessment assigns the unit a Sensitivity of 6 which, using the scale within the document, relates to a ranking of 'outstanding'. It lists the following elements that contribute to this rating:

- A pervading heritage character;
- Historic buildings and associated fences / gardens;
- Groves of mature native trees;
- Notable exotic trees that are associated with historic buildings, particularly specimens of oak and Norfolk Island pine.

Northland Regional Policy Statement

The RPS identifies a number of features in the vicinity of the site as 'Outstanding'. The major source of information used to inform the RPS when identifying landscape features has been the "Inventory (and maps) of Important Geological Sites and Landforms in the Northland Region", Geological Society of New Zealand unpublished report 95/2, edited by J Kenny and B Hayward (1995).

In the vicinity of the subject site, the landscape features are as follows:

Maungakawakawa Scoria Cone (Outstanding Natural Feature). This feature is described as being very good example of small breached scoria cone in the Kaikohe Volcanic Field which is prominent on the skyline when viewed from the east. The cone is centrally located with flows running radially from the vent.

Tarahi Scoria Cone (Outstanding Natural Feature). Located approximately 500m to the south of the site, this feature is decribed as being the highest and most prominent of the scoria cones in the Kaikohe Volcanic Field. This steep-sided scoria cone (750 m diameter) is breached to the NNW, stands approximately 140 m above the surrounding flows, 390 m ASL, and is highest in the Kaikohe Volcanic Field. There is a VHF station on the summit.

Te Ahuahu Volcanic Cone (Outstanding Natural Feature). The foot of this feature is traced by Hariru Road, and is located some 500m to the north west of the site. The New Zealand Geopreservation Inventory describes the feature as being one of the five highest and most prominent steep-sided scoria cones in the Kaikohe Volcanic Field. It comprises a single circular cone, 500 m in diameter, with an E-W trending flow covering a total area of 1.5 square km. The cone stands 100 m above the surrounding plateau, 380 m ASL, but the small crater is shallow.

Within the wider landscape context of the site, the volcanic and other features include the Maungaturoto Volcanic Cone (Outstanding Natural Feature) (2.0km to the south east), Waimitimiti Scoria Mounds (Outstanding Natural Feature) (1.7km to the south west, Te Pua Crater and Flows (Outstanding Natural Feature) (2.0km to the south west) and Lake Omapere (Outstanding Natural Feature) (2.5km to the west).

Far North District Plan

The Far North District Plan identifies the Maungakawakawa Scoria Cone, the Tarahi Scoria Cone, the Te Ahuahu Volcanic Cone, the Maungaturoto Volcanic Cone, Waimitimiti Scoria Mounds, Te Pua Crater and Flows and Lake Omapere within Appendix 1A (Schedule of Outstanding Natural Features) and Appendix 1B (Schedule of Outstanding Landscape Features).

5.3 Archaeological values

The archaeology report[7] states that the density of archaeological sites is high due to the highly fertile volcanic soils suitable for pre-Contact Maori horticultural activities.

It notes that

"*the Te Ahuahu-Ohaeawai-Kaikohe-Waimate North area was an important area of pre-Contact Maori settlement, and European/Maori interaction in the 19th century. The area was also the site of a major battle of the Northern War of 1845-46, between forces allied with the British under Tamati Waka Nene, and those of Hone Heke. The wider landscape is highly archaeologically, historically and culturally significant*."

Although the site contains no scheduled items of cultural significance to Maori (as listed in Appendix 1F of the District Plan), Te Ahuahu and Maungakawakawa are identified as MS 09-04 and MS 09-27 respectively.

The site inspection, undertaken by Geometria revealed an extensive area of stone horticultural mounds on the northern side of the proposed reservoir, over an area of approximately 10ha.

It describes these features as pre or protohistoric Maori horticultural activity on the highly productive soils of the area, probably associated with the nearby kainga (open settlements or villages) and pa sites recorded nearby.

The inspection also identified two possible house floors or storage pits, stacked dry stone walls are also present within the proposal area which it surmises may or may not be archaeological, and taro growing within the stream system.

5.4 Cultural values

The archaeological report notes that the Te Ahuahu-Ohaeawai-Kaikohe-Waimate North area was an important area of pre-Contact Maori settlement, and European/Maori interaction in the 19th century[8].

To be completed following receipt of CIA.

6.0 ASSESSMENT OF LANDSCAPE EFFECTS

6.1 Background

Preceding sections describe the characteristics of the property and site, its setting and the proposal (including mitigation). The purpose of this section is to define the effects of the application upon the site and setting, to consider how the proposal would impact upon the experience of people viewing the development from outside of the site, and to comment upon the level of landscape, natural character, and visual effects.

Landscape change can, but does not necessarily result in adverse visual effects. Natural and human induced change is a constant within the landscape. The key is to manage this in such a way that any adverse visual effects are avoided, remedied or mitigated.

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[7] Geometria. *Archaeological assessment of the proposed MN06 Water Storage Reservoir*, 24 August 2020

[8] Ibid. Section 5.2.

6.2 Assessment of Effects

The effects covered in this assessment, include those that can occur in relation to physical features, viewing audiences and visual amenity and/or on the site's contribution to the existing landscape character and amenity values, as follows:

- Landscape character and amenity effects derive from changes in the physical landscape, which may give rise to changes in its character and how this is experienced. This may in turn affect the perceived value ascribed to the landscape.
- Visual effects relate to the changes that arise in the composition of available views as a result of changes to the landscape, to people's responses to the changes, and to the overall effects with respect to visual amenity.

Landscape and visual impacts can result from change in the components, character or quality of the landscape. Usually these are the result of landform or vegetation modification or the introduction of new structures, facilities or activities. All these impacts are assessed to determine their effects on landscape character and quality, rural amenity and on public and private views. In this report, the assessment of potential effects is based on a combination of the landscape's sensitivity and visibility and the nature and scale of the development proposal.

The nature of landscape and visual effects generated by any particular proposal can, therefore, be:

- Positive (beneficial), contributing to the visual character and quality of the environment.
- Negative (adverse), detracting from existing character and quality of environment; or
- Neutral (benign), with essentially no effect on existing character or quality of environment.

Landscape, and Amenity effects can be rated on a seven-point scale from Very High, through to Very Low.

The degree to which landscape and visual effects are generated by a development depends on several factors, these include:

- The degree to which the proposal contrasts, or is consistent, with the qualities of the surrounding landscape.
- The proportion of the proposal that is visible, determined by the observer's position relative to the objects viewed.
- The distance and foreground context within which the proposal is viewed.
- The area or extent of visual catchment from which the proposal is visible.
- The number of viewers, their location and situation (static or moving) in relation to the view.
- The backdrop and context within which the proposal is viewed
- The predictable and likely known future character of the locality
- The quality of the resultant landscape, its aesthetic values and contribution to the wider landscape character to the area.

Change in a landscape does not, of itself, necessarily constitute an adverse landscape or visual effect. The current proposal, which seeks to introduce a reservoir into the landscape could equally be perceived by an individual as a positive change, or one that is negative. The response depends on the attitude of the individual, and the values that they assign to the affected landscape.

Whilst acknowledging that individuals may experience a positive response to the proposed landscape change, in this assessment, the approach has been taken to assume that individuals will experience a negative response, and assess the level of effect on that basis.

Landscape is dynamic and is constantly changing over time in both subtle and more dramatic transformational ways, these changes are both natural and human induced. What is important in managing landscape change is that adverse effects are avoided or sufficiently mitigated to ameliorate the effects of the change in land use. The aim is to provide a high amenity environment through appropriate design outcomes, including planting that can provide an adequate substitution for the currently experienced amenity.

6.2.1 Biophysical – Abiotic attributes

The key abiotic attributes of the site include the landform, geology, and water catchments. Overall, modification as a result of human processes or human induced processes has been limited to the drainage of some areas of lower lying land, earthworks for the construction of accessways.

The total earthworks volume, allowing for bulking, is expected to be in the order of 255,480m^3. This will comprise a spillway cut of 92,610 m^{3,} a foundation cut of 19,600 m^3 (this includes the topsoil strip of approximately 500mm, and a 3.0m key in central section), and the dam embankment fill of 143,270 m^3 (this includes backfilling stripped & key excavation).

The form and location of the dam is illustrated on Figures 2a, 2b and 2c. The dam will be constructed across a narrow portion of the gully landform.

The proposal will result in a moderate level of localised change in the abiotic attributes – including the changes to the natural landforms and watercourse. Principally, the changes to the landform will result from excavation for the spillway and for the purpose of winning material for the dam construction, and the construction of the dam. Despite the moderate level of change locally, when considered in the context of the wider catchment, the changes will be relatively modest.

6.2.2 Biophysical – Biotic attributes

The biotic attributes of the site are the living organisms which shape an ecosystem.

The ecological report describes in detail the assessed level of effect on the values of the site. It determines that a high level of effect will result from each of the following; the removal of 0.47 ha pūriri forest, from the removal of 0.32 ha swamp forest, 0.75 ha of volcanic boulderfield. A moderate ecological effect will result from each of the following; the removal of 0.44 ha secondary broadleaf forest, the removal of 0.14 ha tōtara treeland, the removal of 1.2 ha of exotic forest and the removal of rata vines and kānuka.

A low ecological effect will result from each of the following; removal of 0.03 ha rautahi wetland, removal of 0.05 ha of kutakuta wetland, removal of 0.22 ha of wet pasture and removal of mānuka

Removal of nationally Threatened swamp maire will result in a very high ecological effect.

The ecological assessment concludes that the overall level of ecological effects on vegetation can be offset and compensated such that 'No Net Loss' of vegetation values can be achieved.

With regard to the adverse ecological effect on fauna, the assessment determines that the effect on bats and kiwi will be very high, the effect on forest birds, the New Zealand pipit and kauri snail will be high, the effect on pacific gecko will be moderate, and the effect on tui and copper skinks will be low.

With the exception of bats and kiwi (more information is required), the assessment states that the above effects can be managed, avoided or offset through management plan mechanisms, or other measures[9].

6.2.3 Experiential and perceptual attributes

Experiential attributes comprise the interpretation of human experience of the landscape. This includes visible changes in the character of the landscape – its naturalness as well as its sense of wildness and remoteness including effects on natural darkness of the night sky.

The proposed dam and area of water containment will be largely screened from the wider landscape (the visual catchment of the site is described in section 4.6 of this report), although more proximate views are possible from stretches of Hariru Road to the north west and west of the site, and from private viewpoints (individual dwellings) accessed from Haruru Road to the north, north west, west and south west.

The numbers of potentially affected individuals is small, however the degree of change experienced by a number of these individuals has the potential to be high.

As has been previously documented, change in a landscape does not, of itself, necessarily constitute an adverse landscape or visual effect and the current proposal could equally be perceived by an individual as a positive change, or one that is negative. The response depends on the attitude of the individual, and the values that they assign to the affected landscape.

For the purpose of this assessment, and to provide a uniform 'worst case' assessment of the potential adverse effect, the assessment of visual amenity effects in section 7.0 has assumed a negative response.

Thus, with respect to the longer term effect of the dam structure and associated reservoir on experiential and perceptual attributes, the level of adverse effect is assessed as being high for the occupants of 5 dwellings, moderate to high for the occupants of 1 dwelling and moderate for the occupants of 2 dwellings. The balance of potentially affected individuals, including users of Hariru Road, will be affected to a low level.

The discussion in section 7.0 has noted that the level of effect can be mitigated to varying levels through the use of riparian planting and other mitigation measures.

It is noted that the potential adverse effects on experiential and perceptual attributes associated with the proposal have the potential to facilitate land use change. Land use change in itself may result in adverse effects on experiential and perceptual attributes. The Hydrological study states that the reservoir would be able to support some 387ha of horticultural land[10]. Whilst noting the potential for such a land use change to result in adverse effects on experiential and perceptual attributes, it is not possible – within the scope of this assessment – to determine the scale of change and the resulting level of effect.

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[9] Ibid. 5.3.2

[10] Williamson Water and Land Advisory. *Hydrology Assessment*, 10 March 2020. Section 2.0

6.2.4 Cultural, spiritual and associative attributes

The archaeological report determines that approximately one hectare of stone mounds, and trenches, and any will be destroyed by the dam wall.

In addition, it states that approximately four hectares of stone mounds, trenches, and a two sections of stone wall will be inundated, and potentially destroyed depending on how the ground is prepared prior to inundation.”

It notes that other features or artefacts may be present within the site and these may be affected.

The report concludes that, whilst not rare, the archaeological features observed are in otherwise good condition and are of moderate archaeological significance, and that the effects of the reservoir project on those features will be high.

Given the historic use of the site and its context, as evidenced by the findings of the archaeology report the community reports a sense of connection to the site and its wider context. This connection is not only associated with the historic use of the land, but is also linked to its ecological values.

It is understood that the community is supportive of measures to off-set biotic effects, and has expressed a desire to be afforded (restricted) access to the site and the remaining archaeological and cultural features.

To be completed on receipt of the CIA

6.2.5 Summary of Landscape Effects

The proposal will result in a moderate degree of localised change with respect to abiotic attributes, but that the change will be small when considered within the context of the wider landscape. The biotic effect of the proposal can be mitigated or offset. With regard to experiential and perceptual values, the proposal will result in a high, or moderate to high impact on a limited number of individuals, and the impact on spiritual, cultural and associative attributes will be high.

Overall therefore, it is assessed that the potential adverse landscape effects generated by the proposal will be moderate locally, once the mitigation measures are completed, and low when considered in the context of the wider environment, again, once the mitigation or offset measures have been implemented.

7.0 ASSESSMENT OF VISUAL AMENITY EFFECTS

As discussed in section 4.6 of this report, the visual catchment of the site is contained to the north, north west, west and south west by the volcanic cones and the ridge associated with these features. The site is visible from locations along Hariru Road, and from properties located along this road. Views from properties to the north east and east – along State Highway 1 are obscured by vegetation.

Whilst the landscape is more open and less elevated to the south east and east, the subject site is not visible from this area, with views blocked by landform.

The potentially affected groups are as follows:

Public viewing audiences

- Road users and pedestrians on Hariru Road

Views to the proposed dam structure are screened from public viewpoints, hidden by landform and vegetation, and as a result of the separation distances between the proposed structure and potential view locations.

The proposed reservoir has the potential to be glimpsed from the northern end of Hariru Road (refer to photos 4, 5 and 6). From these locations, the northern edge of the reservoir, and embankment may be visible across the relatively flat terrain, although due to the separation distance and intervening trees and shelter belts, the embankment and reservoir will not be a dominant element within the field of view.

From locations further to the south along Hariru Road, and to the north west of the site, views to the site are obscured by the spurs which trend to the north east from Maungakawakawa and Tarahi.

Similarly, from locations along Hariru Road to the west of the site, the site is obscured by the spur landforms. Views along the gullys, between the spurs are possible from locations on the road to the south west of the site (refer to photos 7 and 8).

Further to the south west along Hariru Road, and close to its junction with Remuera Settlement Road, views to the site are precluded by the rising landform of Tarahi. Tarahi, and its associated north easterly trending spurs also prevent views to the site from Remuera Settlement Road to the north of its junction with Hariru Road.

Views from State Highway 1 are blocked by vegetation.

It is the opinion of the author that, whilst viewers will appreciate a change when travelling along Hariru Road (particularly when the level of storage within the reservoir is at higher levels), the degree of change will be moderate and the level of potential adverse visual amenity effect will be low.

The level of potential adverse visual amenity effects experienced by users of Remuera Settlement Road and State Highway 1 will be nil.

Private Viewing audiences

- Occupants of dwellings located to the north west of the site,
- Occupants of dwellings located to the west and south west of the site

Occupants of dwellings located to the north west of the site

Dwellings located within Lot 1 DP 442506, Sec 5S Remuera SETT, and a building (Dog trials clubhouse) within Pt Sec 4S Remuera SETT occupy positions on the low-lying terrain between 500m – 800m from the nearest point of the proposed reservoir. Dwellings within the former two properties offer expansive views – albeit fragmented by vegetation – across the landscape to the east, south east and south. Occupants of these dwellings will experience fragmented views of the waterbody.

Viewed from Lot 1 DP 442506 (refer to photo 5), the change resulting from the proposal will be marked, with the reservoir forming a large proportion of the outlook to the south, replacing the existing spur and gully landform with its associated vegetation. In addition, the left embankment will be visible as part of the south easterly outlook from the dwelling. There is potential for the observer's attention to be drawn to this linear feature since it will 'define' the north eastern edge of the reservoir. however, this element will not be dominant within this outlook.

Whilst the degree of change will be high, there is potential to mitigate the change through planting along the watercourses feeding into the reservoir, and around the riparian margins of the waterbody. In addition, 'easing' the down-stream slope of the left embankment will also reduce the prominence of this structure, although the linearity of the reservoir edge will remain evident.

It is the opinion of the author that the occupants of this dwelling will experience a high level of potential adverse visual amenity effect.

This adverse effect has the potential to be mitigated over time to a level that is low to moderate with riparian and other native revegetation plantings where these both serve to fragment and buffer views of the reservoir and left embankment. Furthermore, the prominence of the left embankment can be reduced when viewed from this property by 'easing' the grade of the down-stream slope so that it merges more sensitively with the surrounding terrain.

The dwelling within Sec 5S Remuera SETT is elevated slightly above the dwelling within Lot 1 DP 442506 and so has the ability to gain views 'down' toward the reservoir (refer to photo 2). Views to the site are however, partially screened by existing vegetation and by the spur landforms and it is judged that, although views of the reservoir will be possible, these will be longer views to the middle and south eastern portion of the waterbody.

The degree of change will be moderate, with the primary easterly outlook from the dwelling remaining unchanged, and as with the previous affected dwelling, there is potential to mitigate the change through planting along the watercourses feeding into the reservoir, and around the riparian margins of the waterbody.

It is the opinion of the author that the occupants of this dwelling will experience a moderate level of potential adverse visual amenity effect. This adverse effect has the potential to be mitigated over time to a level that is low with riparian and other native revegetation plantings.

Occupants of dwellings located to the west and south west of the site.

Views to the proposed reservoir will not be possible from the dwelling within Lot 1 DP 378424, whilst the dwellings within Sec 50S Remuera SETT and Lot 1 DP 157098, will have the potential to gain glimpse views of the extreme north western edge of the reservoir. It is likely that they will notice the loss of an area of existing vegetation which occupies the north eastern 'arm' of the reservoir, and the presence of water within this arm. They will not be able to see the left embankment. Occupants of these latter two dwellings will experienced a low degree of change and, in the opinion of the author, a low potential adverse visual amenity effect.

A group of dwellings which occupy more elevated locations on the eastern flank of Maungakawakawa. Identified as being located within Pt Hariru B and Poukai A, Sec 58S Remuera SETT, Lot 1 DP 322598 (refer to photo 2), and Lot 1 DP 359593, these dwellings offer views to the east and north east over the Te Ruaotehauhau basin.

Separated by a minimum of some 600 – 800 metres from the edge of the proposed reservoir, occupants of these dwellings currently experience elevated, long and expansive views of the rural landscape to the east, north east and south east.

The spurs which project to the north east form a fore / midground, and frame views down into the basin. The interplay between topography, vegetation and pasture lends midground component of the outlook a high degree of amenity (refer to photos 7 and 8). The distant landscape includes views of the Maungaturoto and Pourerua cones, and in the far distance, the forested hills on the northern edge of Moerewa.

The individual dwellings offer varying degrees of exposure with respect to views over the site. The dwelling within Pt Hariru B and Poukai A (refer to photo 9) is situated at a slightly lower elevation and is partially buffered by vegetation whilst the two storey dwelling within Sec 58S Remuera SETT (visible in photo 2) offers a more complete view of the site.

The proposal will result in a noticeable modification to the midground component of the view with a high degree of change for these individuals. The foreground context to the view – being the north easterly trending spurs – will provide some separation between the reservoir and these viewers and this will serve to 'integrate' the feature into the landscape. The left embankment will be apparent as a linear element, delineated by the edge of the waterbody, but the dam within the gully will not be visible.

Occupants of Pt Hariru B and Poukai A and Lot 1 DP 322598 will, in the opinion of the author, experience a moderate to high level of potential adverse visual amenity effect. Occupants of Sec 58S Remuera SETT, Lot 1 DP 322598 and Lot 1 DP 359593 will experience a high level of potential adverse visual amenity effect.

There is the potential to mitigate these adverse effects to some degree using riparian revegetation. This will serve to both integrate the waterbody with the terrain, thereby lending it a amore natural appearance, and also fragmenting views of the waterbody. Given the elevation of these individuals, screening of the entirety of the feature will not be possible.

Two dwellings located to the south west, within Sec 16S Remuera SETT and Pt Sec 21S Remuera SETT offer elevated views across and over the site from the south western flanks of Tarahi. Occupants of the former dwelling will have the ability to observe the majority of the proposed reservoir, whilst occupants of the latter will have the potential to see its western half.

The degree of change with respect to these individuals will be high. The level of potential adverse visual amenity effect is assessed as being high for the former, and moderate to high for the latter. As with the previously described properties to the west of the site, mitigation planting will afford some degree of mitigation for these individuals, but such planting will serve to integrate the feature rather than screen it.

9.0 EFFECTS ON STATUTORY INSTRUMENTS

The key themes which arise from the relevant objectives and policies contained in the Northland Regional Policy Statement focus on the protection of, and the avoidance of adverse effects on outstanding natural features and landscapes and outstanding natural character. The Site is spatially separated from nearby features and will not adversely affect those features.

The values of the Te Ruaotehauhau Stream are described in the ecological report. The report determines the stream and its associated vegetation displays high values. The landscape values are described in section 5 of this document. Overall, the stream is determined to display a moderate level of natural character, noting that for much of its length, it flows within a modified pastoral landscape.

The proposal will result in the loss of a modification of approximately 2,114 m of continually flowing permanent stream and approximately 538m of intermittently flowing stream. The filling of the reservoir will impact the main stems and tributaries across the site, turning them from relatively natural, hard-bottom streams to lake type habitat[11].

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[11] Ibid Section 4.2.4

The ecology report concludes that the potential adverse effects resulting from the proposal on freshwater ecosystems and fauna can be mitigated through implementation of management plans and residual adverse effects addressed through offset or compensation measures on similar habitats in the wider catchment.

The change in relation to the experiential and perceptual attributes of natural character will be limited in magnitude, given the separation between potential viewers and the Site. Individuals will recognise a change as a result of the loss of riparian vegetation, but within the wider landscape context, this change will be small. Overall, it is the opinion of the author that the potential adverse natural character effect of the proposal will be low, once the offset or compensation measures have been implemented.

Objectives and policies in Chapter 8 of the District Plan focus on the protection of outstanding natural features and landscape, the maintenance of rural character and amenity, and the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna.

The proposal will result in the introduction of a water body into the landscape. Although the water body will be recognised as a man-made construction – due to the presence of the dam embankment and during periods of draw-down – it will be integrated into the contextual terrain and vegetative patterns. Furthermore, dams are relatively common as features of the rural environment, and are perceived as accepted features of the rural landscape.

The proposal will, therefore result in a low adverse effect on rural character.

10.0 CONCLUSION

The application seeks to construct a new water supply reservoir, by constructing a dam across the Te Ruaotehauhau Stream, and inundating a section of its headwaters, and surrounding land. The proposed reservoir will have a storage volume of 1,400,000 cubic metre (m^3) (at full supply level).

The proposal includes a landscape and visual mitigation concept which, it is proposed be developed as a condition of consent in conjunction with the project ecologist.

The assessment has determined that the potential adverse landscape effect of the proposal will be moderate locally, once the mitigation measures are completed, and low when considered in the context of the wider environment, again, once the mitigation or offset measures have been implemented.

The level of potential adverse visual effect is assessed as being high for the occupants of 5 dwellings, moderate to high for the occupants of 1 dwelling and moderate for the occupants of 2 dwellings. The balance of potentially affected individuals, including users of Hariru Road, will be affected to a low level.

A number of recommendations are included to assist with the mitigation of potential adverse landscape and visual amenity effects. These are as follows:

- Where material is excavated for use in the dam construction, that the final landform be shaped to reflect, and integrate with the adjoining unmodified landform. These areas shall be covered with topsoil and regrassed for grazing, or planted with trees, or native revegetation;
- That the downstream slope of the left hand embankment be graded such that the slope is 'eased' to a more gentle gradient so that it merges naturally into the adjoining terrain;
- That a landscape mitigation and management plan be required as a condition of consent. This plan should be

developed in consultation with local landowners, and in conjunction with the ecological Offset and Compensation Plan, and;

- That pedestrian access to the dam margins be investigated.

The proposal is considered to be consistent with the objectives and policies of the various statutory instruments where they are of relevance to this assessment.

Overall, the proposal can be supported from a landscape and visual perspective.

Simon Cocker

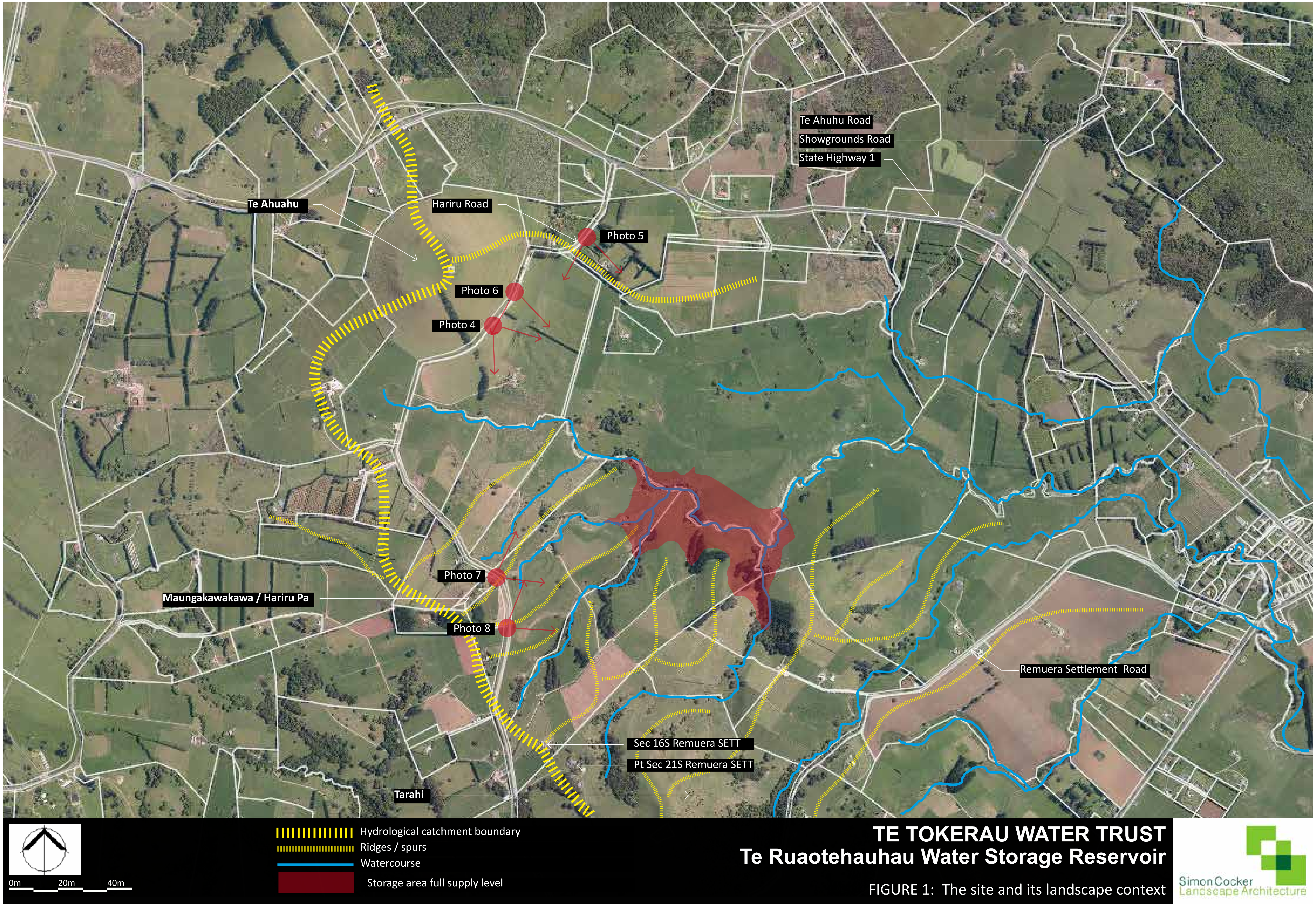
Registered Landscape Architect.

1 September 2020

NEW ZEALAND INSTITUTE OF LANDSCAPE ARCHITECTS

REGISTERED
LANDSCAPE
ARCHITECT

Appendix 1: Figures



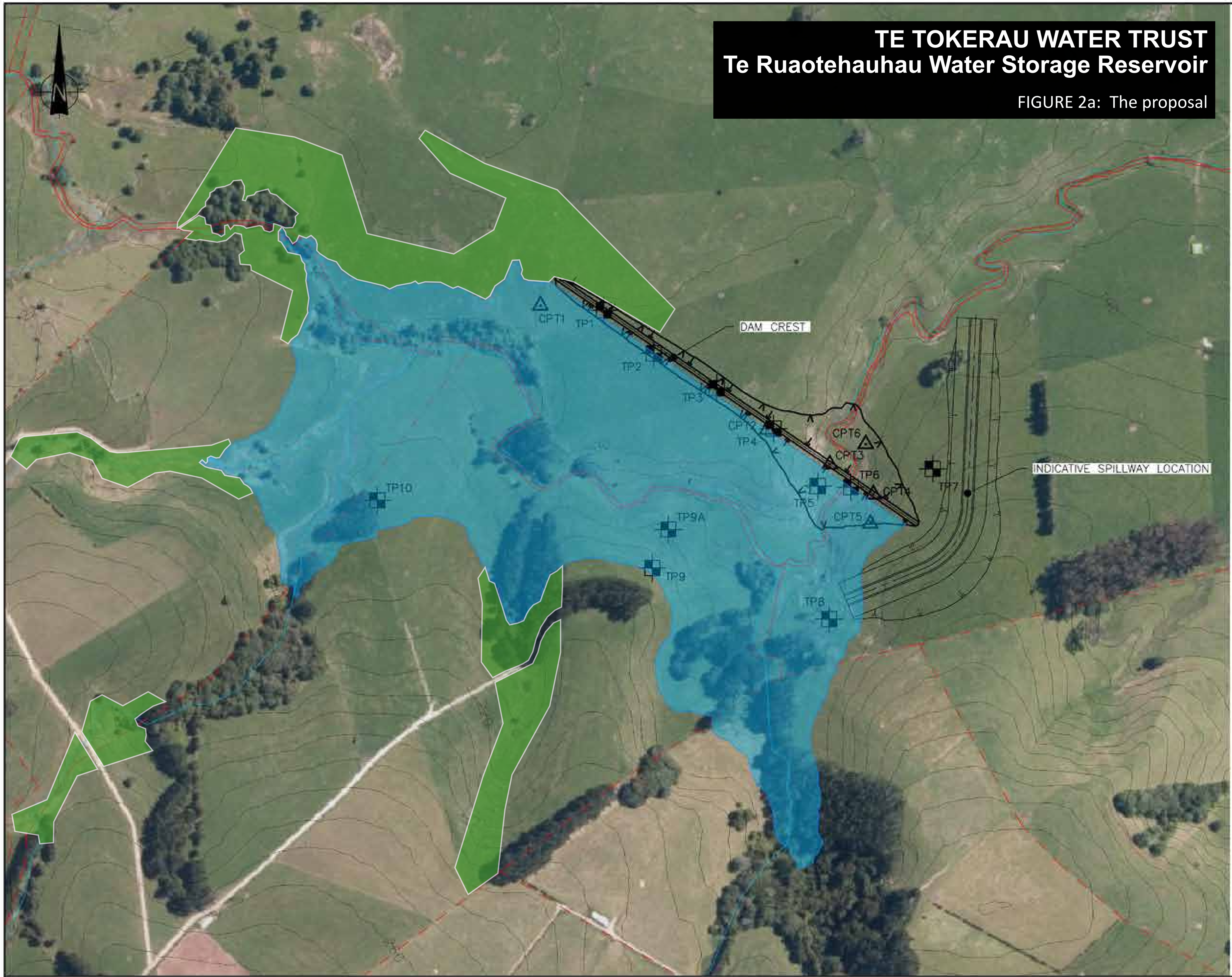
TE TOKERAU WATER TRUST
Te Ruaotehauhau Water Storage Reservoir

FIGURE 1: The site and its landscape context

Simon Cocker
Landscape Architecture

TE TOKERAU WATER TRUST
Te Ruaotehauhau Water Storage Reservoir

FIGURE 2a: The proposal



LEGEND

- 5m CONTOURS
- PROPERTY BOUNDARY
- STREAM CHANNELS
- INUNDATION TO FULL SUPPLY LEVEL (FSL)
- TP1 TEST PIT
- CPT1 CONE PENETROMETER TEST

REFERENCE NOTES:

1. CONTOURS AND AERIAL PHOTO SOURCED FROM 2019 NORTHLAND REGIONAL COUNCIL LIDAR.
2. MAXIMUM INNUNDATION AREA ILLUSTRATES THE AREA LIKEY TO BE INNUNDATED ASSUMING A NOMINAL 20m BUFFER.

40 0 80 160m

SCALE 1:4000

DRAFT FOR INFORMATION

REV	DATE	ISSUE	BY
1		DRAFT FOR INFORMATION	MP

DESIGN: EM
DES. CHECK:
DRAWN: MP
CAD CHECK:
APPROVED FOR ISSUE: DRAFT
DATE DRAWN: AUG. 2020
ISSUE DATE: 05 / 08 / 20

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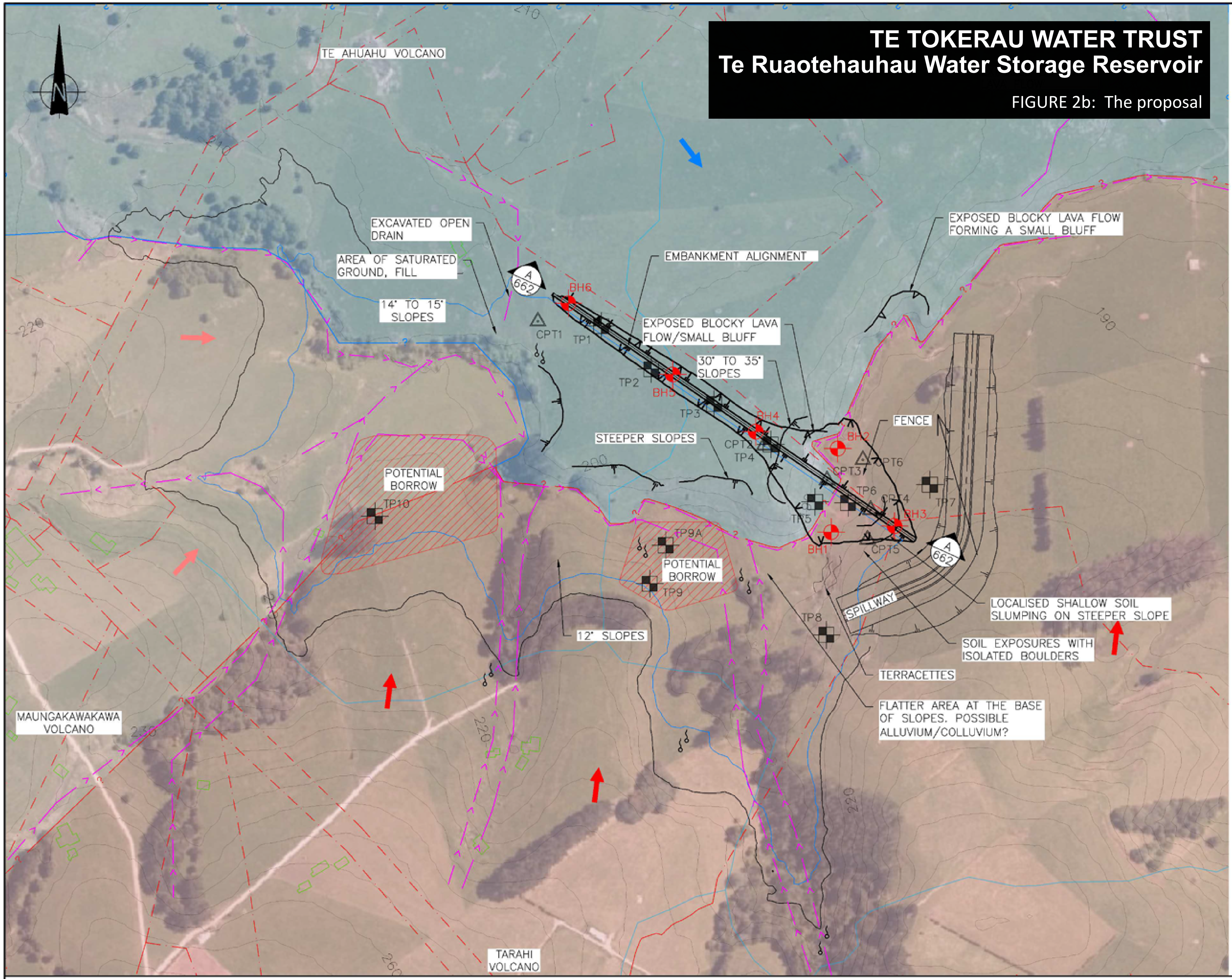
CLIENT: TE TAI TOKERAU WATER TRUST
ADDRESS: NORTHLAND
PROJECT: WATER STORAGE AND USE PROJECT
SHEET TITLE: DAM06 - SITE PLAN AND INVESTIGATIONS

CADFILE: 200249_3-102.dwg
SCALE (A3): 1:4000
ORIG. SHEET SIZE: A3
DRAWING No.: 200249/3-102
REV: 1

TE TOKERAU WATER TRUST
Te Ruaotehauhau Water Storage Reservoir

FIGURE 2b: The proposal



LEGEND

5m CONTOURS
PROPERTY BOUNDARY
STREAM CHANNEL
SCARP
SPRING
CPT1 CPT LOCATION
TP1 TEST PIT LOCATION
BH1 PROPOSED BOREHOLE LOCATION
INFERRED BASALTIC LAVA FLOW FROM MAUNGAKAWAKAWA VOLCANO
INFERRED BASALTIC LAVA FLOW FROM TARAHI VOLCANO
INFERRED BASALTIC LAVA FLOW FROM TE AHUAHU VOLCANO
EMBANKMENT STRUCTURE

REFERENCE NOTES:

1. CONTOURS AND AERIAL PHOTO SOURCED FROM 2019 NORTHLAND REGIONAL COUNCIL LIDAR.
2. MAXIMUM INUNDATION AREA ILLUSTRATES THE AREA LIKEY TO BE INUNDATED ASSUMING A NOMINAL 20m BUFFER.

40 0 80 160m
SCALE 1:4000

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SHEET TITLE: DAM MN06 - GEOMORPHIC AND GEOLOGIC MAP

CADFILE: 200249_3-101.dwg
SCALE (A3): 1:4000
ORIG. SHEET SIZE: A3
DRAWING No.: 200249/3-101
REV.: 1

TE TOKERAU WATER TRUST
Te Ruaotehauhau Water Storage Reservoir

FIGURE 2c: The proposal

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SHEET TITLE: DAM MN06 - DIVERSION AND SEDIMENT CONTROL WORKS

CADFILE: 200249_3-106.dwg
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ORIG. SHEET SIZE: A3
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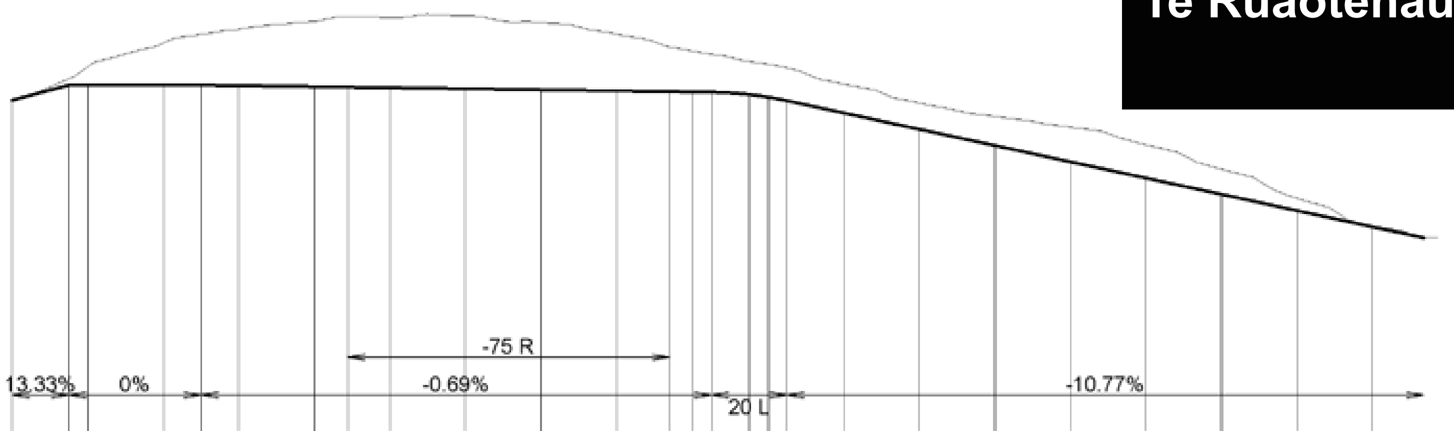
REV: 1

TE TOKERAU WATER TRUST
Te Ruaotehauhau Water Storage Reservoir

FIGURE 2d: The proposal



HORIZONTAL ALIGNMENT
VERTICAL ALIGNMENT
DATUM 158.00

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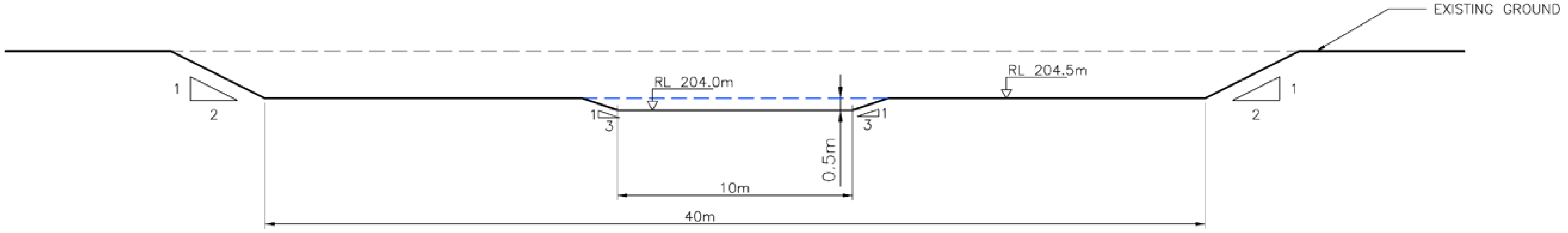
EXISTING SURFACE LEVELS	201.81	204.83	206.41	209.58	210.69	211.37	212.41	213.05	212.89	213.18	212.29	210.73	209.05	208.50
CUT - / FILL +	0.19	-0.83	-2.41	-5.58	-6.69	-7.44	-8.61	-9.32	-9.24	-9.67	-8.91	-7.48	-5.90	-5.40
CHAINAGE	0.00	15.00	20.00	40.00	50.00	60.00	80.00	88.76	100.00	120.00	140.00	160.00	173.93	180.00

DESIGN SURFACE LEVELS	203.07	202.75	202.40	201.92	200.31	198.16	196.00	193.85	191.70	189.54	187.39	185.24	
EXISTING SURFACE LEVELS	208.07	207.12	206.74	206.27	204.13	201.62	199.85	198.44	196.10	192.88	189.02	185.39	183.74
CUT - / FILL +	-5.00	-4.37	-4.34	-4.35	-3.83	-3.47	-3.85	-4.59	-4.40	-3.33	-1.63	-0.15	
CHAINAGE	185.00	195.00	200.00	205.00	220.00	240.00	260.00	280.00	300.00	320.00	340.00	360.00	377.07

20 0 40 80m
SCALE 1:2000

SPILLWAY LONG SECTION

SCALE 1: 2000 HOR 1:1000 VERT



SPILLWAY CROSS SECTION

SCALE 1:200

2 0 4 8m
SCALE 1:200

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SHEET TITLE DAM MN06 - SPILLWAY DETAILS

CADFILE 200249_3–105.dwg
SCALE (A3) AS SHOWN
ORIG. SHEET SIZE A3
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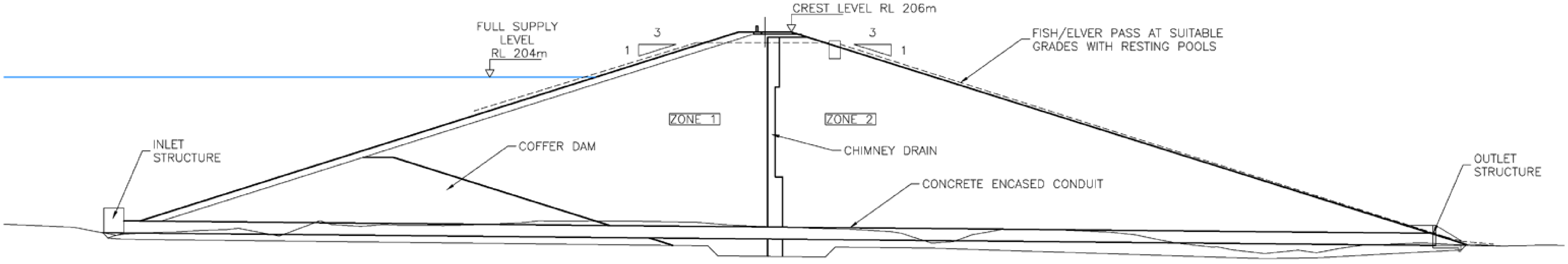
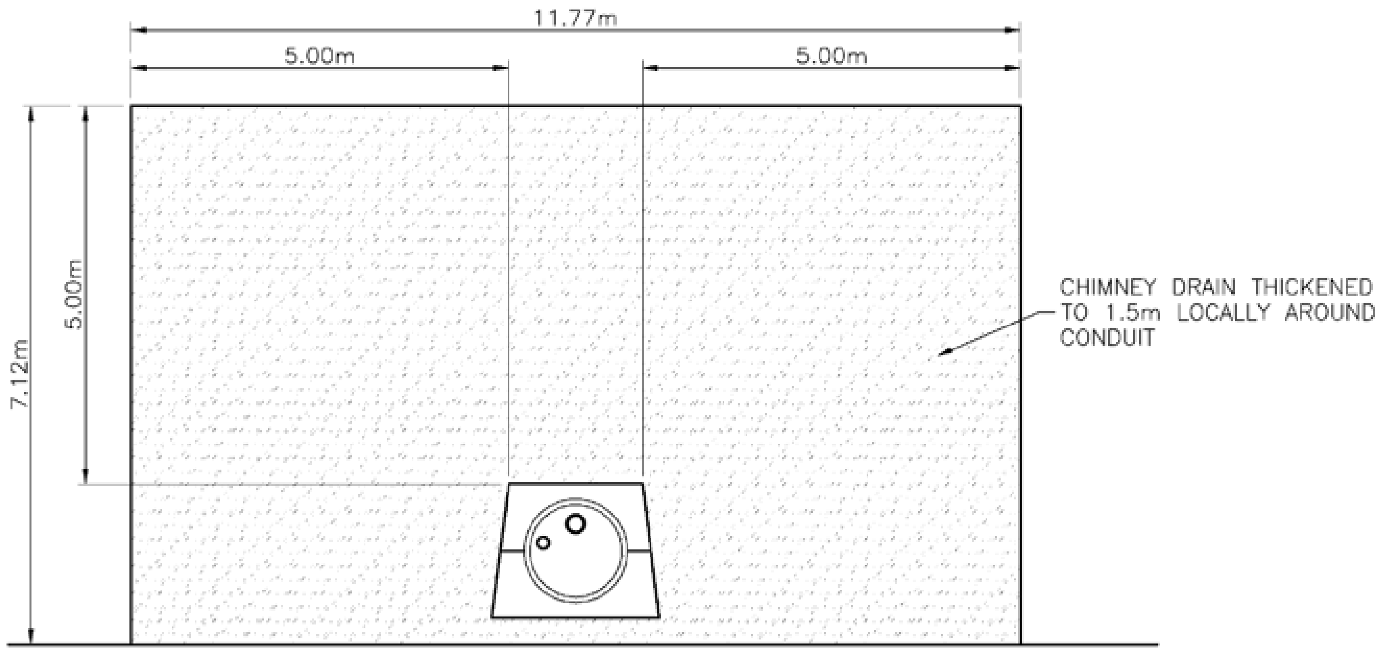
REV. 1

TE TOKERAU WATER TRUST
Te Ruaotehauhau Water Storage Reservoir

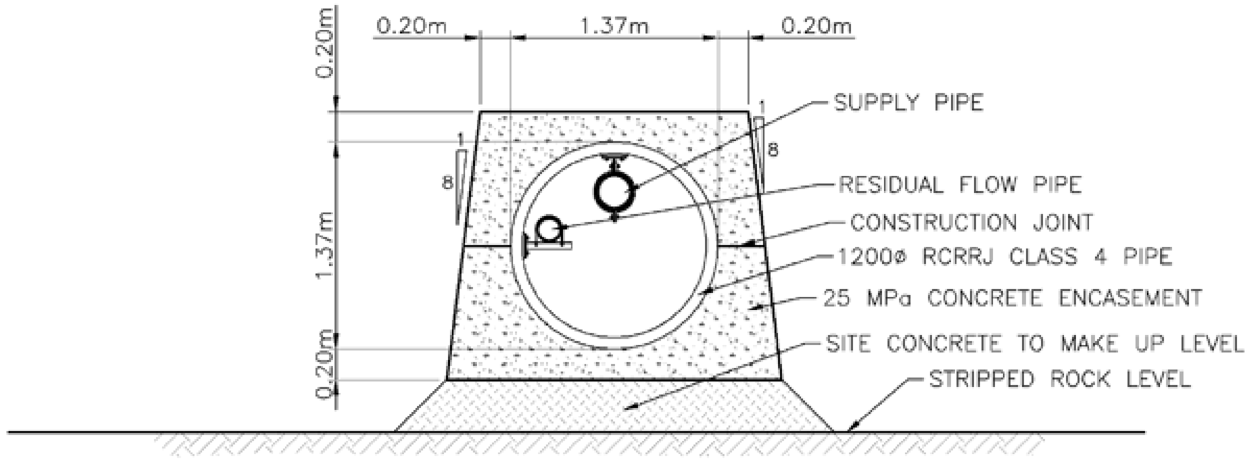
FIGURE 2e: The proposal



DAM SECTION AT CONDUIT
SCALE 1:400



DETAIL A - CHIMNEY DRAIN THICKENING AT CONDUIT
SCALE 1:100



DETAIL A - CONDUIT & ENCASEMENT DETAIL
SCALE 1:20

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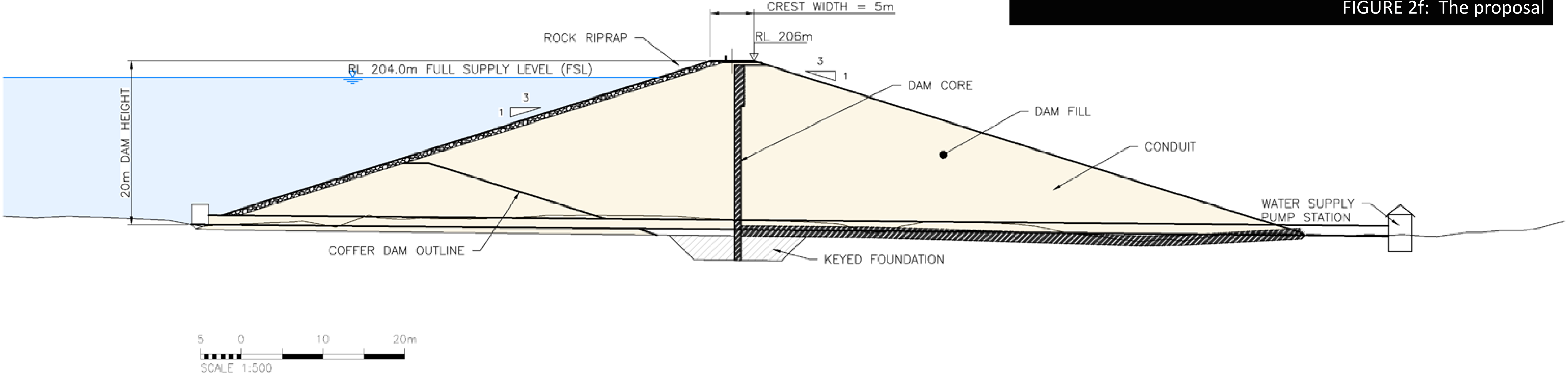
ADDRESS: NORTHLAND
PROJECT: NORTHLAND WATER STORAGE AND USE PROJECT
SHEET TITLE: DAM MN06 - CONDUIT & FISH PASS DETAILS

CADFILE: 200249_3-104.dwg
SCALE (A3): AS SHOWN
ORIG. SHEET SIZE: A3
DRAWING No.: 200249/3-104
REV.: 1

TE TOKERAU WATER TRUST
Te Ruaotehauhau Water Storage Reservoir

FIGURE 2f: The proposal



TYPICAL DAM CROSS SECTION

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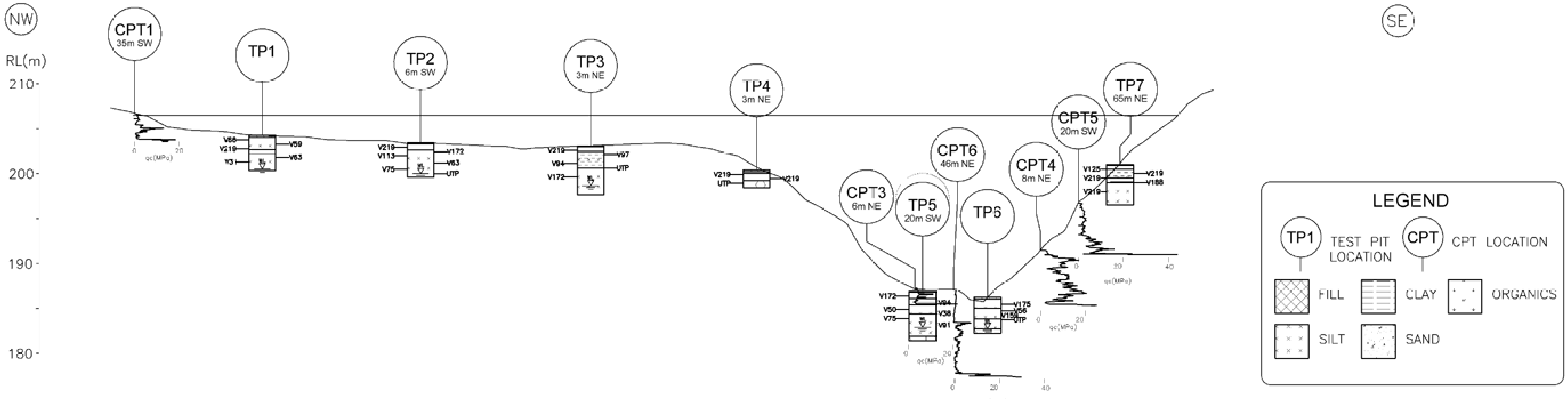

SECTION A
102

SCALE 1:2000 HORIZONTAL
1:250 VERTICAL

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CLIENT	TE TAI TOKERAU WATER TRUST
ADDRESS	NORTHLAND
PROJECT	WATER STORAGE AND USE PROJECT
SHEET TITLE	DAM06 - CROSS SECTION & GEOTECHNICAL SECTION A

ACENZ

CADFILE 200249_3–103.dwg	
SCALE (A3) AS SHOWN	ORIG. SHEET SIZE A3
DRAWING No. 200249/3-103	REV. 1

🟩 Potential riparian & offset revegetation planting

🟥 Storage area full supply level

TE TOKERAU WATER TRUST
Te Ruaotehauhau Water Storage Reservoir

FIGURE 2g: Indicative landscape mitigation concept

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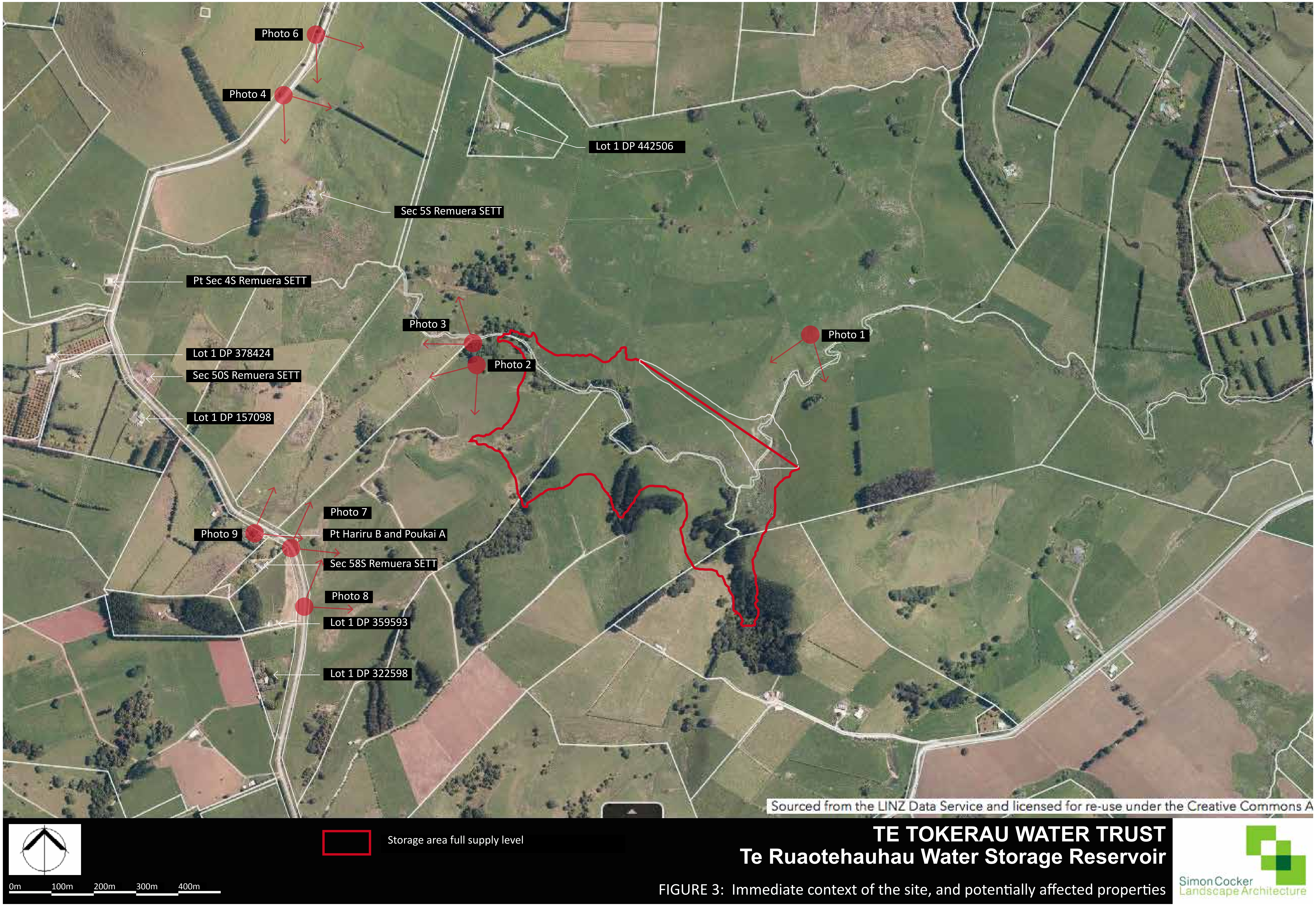

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TE TOKERAU WATER TRUST
Te Ruaotehauhau Water Storage Reservoir

FIGURE 3: Immediate context of the site, and potentially affected properties

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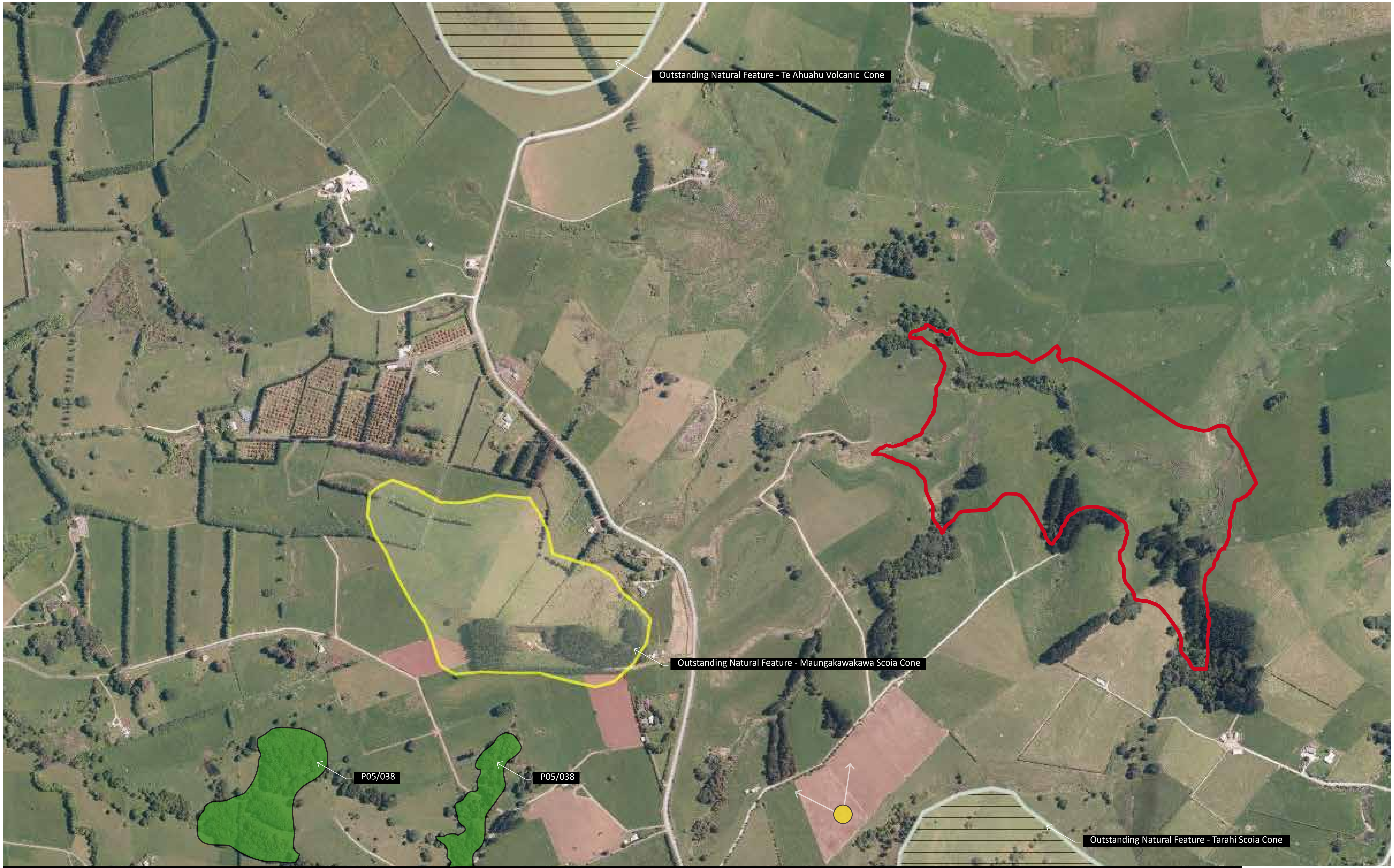

🟥 Storage area full supply level

TE TOKERAU WATER TRUST
Aratapu Water Storage Reservoir

FIGURE 4: Identified values

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Photo 1: View south west alomng gully toward location of proposed dam embankment

Photo date: 10 June 2020.

Te Ruaotehauhau Water Storage Reservoir

Photographs

Photos taken with digital equivalent of 50mm focal length unless otherwise specified.

Photos represent a 124° horizontal and 55° vertical field of view, and should be read at a distant of 400mm

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Photo 2: View north west to Maungakawakawa and Hariru Road

Photo date: 13 July 2020.

Te Ruaotehauhau Water Storage Reservoir

Photographs

Photos taken with digital equivalent of 50mm focal length unless otherwise specified.
Photos represent a 124° horizontal and 55° vertical field of view, and should be read at a distant of 400mm

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Photo 3: View to north west toward Te Ahuahu and Hariru Road

Photo date: 16 July 2020.

Te Ruaotehauhau Water Storage Reservoir

Photographs

Photos taken with digital equivalent of 50mm focal length unless otherwise specified.
Photos represent a 124° horizontal and 55° vertical field of view, and should be read at a distant of 400mm

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Landscape Architecture

Photo 4: View south east from Hariru Road

Photo date: 16 July 2020.

Te Ruaotehauhau Water Storage Reservoir

Photographs

Photos taken with digital equivalent of 50mm focal length unless otherwise specified.
Photos represent a 124° horizontal and 55° vertical field of view, and should be read at a distant of 400mm

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Photo 5: View south from entrance to Lot 1 DP 442506, Hariru Road

Photo date: 27 July 2020.

Te Ruaotehauhau Water Storage Reservoir

Photographs

Photos taken with digital equivalent of 50mm focal length unless otherwise specified.
Photos represent a 124° horizontal and 55° vertical field of view, and should be read at a distant of 400mm

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Photo 6: View south east from Hariru Road

Photo date: 16 July 2020.

Te Ruaotehauhau Water Storage Reservoir

Photographs

Photos taken with digital equivalent of 50mm focal length unless otherwise specified.
Photos represent a 124° horizontal and 55° vertical field of view, and should be read at a distant of 400mm

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Photo 7: View north east from Hariru Road

Photo date: 16 July 2020.

Te Ruaotehauhau Water Storage Reservoir

Photographs

Photos taken with digital equivalent of 50mm focal length unless otherwise specified.
Photos represent a 124° horizontal and 55° vertical field of view, and should be read at a distant of 400mm

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Photo 8: View north east from Hariru Road

Photo date: 16 July 2020.

Te Ruaotehauhau Water Storage Reservoir

Photographs

Photos taken with digital equivalent of 50mm focal length unless otherwise specified.
Photos represent a 124° horizontal and 55° vertical field of view, and should be read at a distant of 400mm

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Photo 9: View east from Pt Hariru B and Poukai A

Photo date: 27 August 2020.

Te Ruaotehauhau Water Storage Reservoir

Photographs

Photos taken with digital equivalent of 50mm focal length unless otherwise specified.
Photos represent a 124° horizontal and 55° vertical field of view, and should be read at a distant of 400mm

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Landscape Architecture

Appendix 2: Landscape and visual effects assessment methodology

Landscape and Visual Effects Assessment Methodology

Introduction

The landscape and visual effects assessment process provides a framework for assessing and identifying the nature and level of likely effects that may result from a proposed development. Such effects can occur in relation to changes to physical elements, the existing character of the landscape and the experience of it. In addition, the landscape assessment method may include an iterative design development processes which includes stakeholder involvement. The outcome of any assessment approach should seek to avoid, remedy or mitigate adverse effects. A separate assessment is required to assess changes in natural character in coastal areas and other waterbodies.

When undertaking landscape and visual effects assessments, it is important that a structured and consistent approach is used to ensure that findings are clear and objective. Judgement should always be based on skills and experience, and be supported by explicit evidence and reasoned argument.

While landscape and visual effects assessments are closely related, they form separate procedures. The assessment of the potential effect on the landscape forms the first step in this process and is carried out as an effect on an environmental resource (i.e. landscape elements, features and character). The assessment of visual effects considers how changes to the physical landscape affect the viewing audience. The types of effects can be summarised as follows:

> **Landscape effects:**
> *Change in the physical landscape, which may change its characteristics or qualities.*
>
> **Visual effects:**
> *Change to views which may change the visual amenity experienced by people.*

The policy context, existing landscape resource and locations from which a development or change is visible all inform the 'baseline' for landscape and visual effects assessments. To assess effects, the landscape must first be described, including an understanding of the key landscape characteristics and qualities. This process, known as landscape characterisation, is the basic tool for understanding landscape character and may involve subdividing the landscape into character areas or types. The condition of the landscape (i.e. the state of an individual area of landscape or landscape feature) should also be described alongside a judgement made on the value or importance of the potentially affected landscape.

This outline of the landscape and visual effects assessment methodology has been undertaken with reference to the Quality Planning Landscape Guidance Note1[1] and its signposts to examples of best practice which include the UK guidelines for landscape and visual impact assessment[2] and the New Zealand Landscape Institute Guidelines for Landscape Assessment[3].

Assessing landscape effects requires an understanding of the nature of the landscape resource and the magnitude of change which results from a proposed development to determine the overall level of landscape effects.

Nature of the landscape resource

Assessing the nature of the landscape resource considers both the susceptibility of an area of landscape to change and the value of the landscape. This will vary upon the following factors:

- Physical elements such as topography / hydrology / soils / vegetation;
- Existing land use;
- The pattern and scale of the landscape;

---

[1] http://www.qualityplanning.org.nz/index.php/planning-tools/land/landscape

[2] Landscape Institute and Institute of Environmental Management and Assessment (2013) Guidelines for Landscape and Visual Impact Assessment, 3rd Edition (GLVIA3)

[3] Best Practice Note Landscape Assessment and Sustainable Management 10.1, NZILA

- Visual enclosure / openness of views and distribution of the viewing audience;
- The zoning of the land and its associated anticipated level of development;
- The value or importance placed on the landscape, particularly those confirmed in statutory
- documents; and
- The scope for mitigation, appropriate to the existing landscape.

The susceptibility to change takes account of both the attributes of the receiving environment and the characteristics of the proposed development. It considers the ability of a specific type of change occurring without generating adverse effects and/or achievement of landscape planning policies and strategies.

Landscape value derives from the importance that people and communities, including tangata whenua, attach to particular landscapes and landscape attributes. This may include the classification of

Outstanding Natural Landscape (RMA s.6(b)) based on important biophysical, sensory/ aesthetic and associative landscape attributes, which have potential to be affected by a proposed development.

Magnitude of Landscape Change

The magnitude of landscape change judges the amount of change that is likely to occur to existing areas of landscape, landscape features, or key landscape attributes. In undertaking this assessment, it is important that the size or scale of the change is considered within the geographical extent of the area influenced and the duration of change, including whether the change is reversible. In some situations, the loss /change or enhancement to existing landscape elements such as vegetation or earthworks should also be quantified.

When assessing the level of landscape effects, it is important to be clear about what factors have been considered when making professional judgements. This can include consideration of any benefits which result from a proposed development. Table 1 below helps to explain this process. The tabulating of effects is only intended to inform overall judgements.

Contributing factors		Higher	Lower
Nature of Landscape Resource	**Susceptibility to change**	The landscape context has limited existing landscape detractors which make it highly vulnerable to the type of change which would result from the proposed development.	The landscape context has many detractors and can easily accommodate the proposed development without undue consequences to landscape character.
	The value of the landscape	The landscape includes important biophysical, sensory and associative attributes. The landscape requires protection as a matter of national importance (ONF/L).	The landscape lacks any important biophysical, sensory or associative attributes. The landscape is of low or local importance.
Magnitude of Change	**Size or scale**	Total loss or addition of key features or elements. Major changes in the key characteristics of the landscape, including significant aesthetic or perceptual elements.	The majority of key features or elements are retained. Key characteristics of the landscape remain intact with limited aesthetic or perceptual change apparent.
	Geographical extent	Wider landscape scale.	Site scale, immediate setting.
	Duration and reversibility	Permanent. Long term (over 10 years).	Reversible. Short Term (0-5 years).

Table 1: Determining the level of landscape effects

Visual Effects

To assess the visual effects of a proposed development on a landscape, a visual baseline must first be defined. The visual 'baseline' forms a technical exercise which identifies the area where the development may be visible, the potential viewing audience, and the key representative public viewpoints from which visual effects are assessed.

The viewing audience comprises the individuals or groups of people occupying or using the properties, roads, footpaths and public open spaces that lie within the visual envelope or 'zone of visual influence' of the site and proposal. Where possible, computer modelling can assist to determine the theoretical extent of visibility together with field work undertaken to confirm this. Where appropriate, key representative viewpoints should be agreed with the relevant local authority.

Nature of the viewing audience

The nature of the viewing audience is assessed in terms of the susceptibility of the viewing audience to change and the value attached to views. The susceptibility of the viewing audience is determined by assessing the occupation or activity of people experiencing the view at particular locations and the extent to which their interest or activity may be focused on views of the surrounding landscape. This relies on a landscape architect's judgement in respect of visual amenity and reaction of people who may be affected by a proposal. This should also recognise that people more susceptible to change generally include: residents at home, people engaged in outdoor recreation whose attention or interest is likely to be focused on the landscape and on particular views; visitors to heritage assets or other important visitor attractions; and communities where views contribute to the landscape setting.

The value or importance attached to particular views may be determined with respect to its popularity or numbers of people affected or reference to planning instruments such as viewshafts or view corridors.

Important viewpoints are also likely to appear in guide books or tourist maps and may include facilities provided for its enjoyment. There may also be references to this in literature or art, which also acknowledge a level of recognition and importance.

Magnitude of Visual Change

The assessment of visual effects also considers the potential magnitude of change which will result from views of a proposed development. This takes account of the size or scale of the effect, the geographical extent of views and the duration of visual change which may distinguish between temporary (often associated with construction) and permanent effects where relevant. Preparation of any simulations of visual change to assist this process should be guided by best practice as identified by the NZILA[4].

When determining the overall level of visual effect, the nature of the viewing audience is considered together with the magnitude of change resulting from the proposed development. Table 2 has been prepared to help guide this process:

Contributing factors		Higher	Lower
Nature of Landscape Resource	**Susceptibility to change**	Views from dwellings and recreation areas where attention is typically focussed on the landscape..	Views from places of employment and other places where the focus is typically incidental to its landscape context. Views from transport corridors.
	The value of the landscape	Viewpoint is recognised by the community such as an important view shaft, identification on tourist maps or in art and literature. High visitor numbers.	Viewpoint is not typically recognised or valued by the community. Infrequent visitor numbers..
Magnitude of Change	**Size or scale**	Loss or addition of key features in the view. High degree of contrast with existing landscape elements (i.e. in terms of form scale, mass, line, height, colour and texture). Full view of the proposed development	Most key features of view retained. Low degree of contrast with existing landscape elements (i.e. in terms of form scale, mass, line, height, colour and texture. Glimpse / no view of the proposed development.
	Geographical extent	Front on views. Near distance views; Change visible across a wide area.	Oblique views. Long distance views. Small portion of change visible.
	Duration and reversibility	Permanent. Long term (over 15 years).	Transient / temporary. Short Term (0-5 years).

---

[4] Best Practice Guide: Visual Simulations BPG 10.2, NZILA

Nature of Effects

In combination with assessing the level of effects, the landscape and visual effects assessment also considers the nature of effects in terms of whether this will be positive (beneficial) or negative (adverse) in the context within which it occurs. Neutral effects can also occur where landscape or visual change is benign.

It should also be noted that a change in a landscape does not, of itself, necessarily constitute an adverse landscape or visual effect. Landscape is dynamic and is constantly changing over time in both subtle and more dramatic transformational ways, these changes are both natural and human induced. What is important in managing landscape change is that adverse effects are avoided or sufficiently mitigated to ameliorate the effects of the change in land use. The aim is to provide a high amenity environment through appropriate design outcomes.

This assessment of the nature effects can be further guided by Table 3 set out below:

Nature of effect	Use and definition
Adverse (negative):	The proposed development would be out of scale with the landscape or at odds with the local pattern and landform which results in a reduction in landscape and / or visual amenity values
Neutral (benign):	The proposed development would complement (or blend in with) the scale, landform and pattern of the landscape maintaining existing landscape and / or visual amenity values
Beneficial (positive):	The proposed development would enhance the landscape and / or visual amenity through removal of restoration of existing degraded landscapes uses and / or addition of positive elements or features

Table 3: Determining the Nature of Effects

Cumulative Effects

During the scoping of an assessment, where appropriate, agreement should be reached with the relevant local authority as to the nature of cumulative effects to be assessed. This can include effects of the same type of development (e.g. wind farms) or the combined effect of all past, present and approved future development[5] of varying types, taking account of both the permitted baseline and receiving environment. Cumulative effects can also be positive, negative or benign.

Cumulative Landscape Effects

Cumulative landscape effects can include additional or combined changes in components of the landscape and changes in the overall landscape character. The extent within which cumulative landscape effects are assessed can cover the entire landscape character area within which the proposal is located, or alternatively, the zone of visual influence from which the proposal can be observed.

Cumulative Visual Effects

Cumulative visual effects can occur in combination (seen together in the same view), in succession (where the observer needs to turn their head) or sequentially (with a time lapse between instances where proposals are visible when moving through a landscape). Further visualisations may be required to indicate the change in view compared with the appearance of the project on its own.

Determining the nature and level of cumulative landscape and visual effects should adopt the same approach as the project assessment in describing both the nature of the viewing audience and magnitude of change leading to a final judgement. Mitigation may require broader consideration which may extend beyond the geographical extent of the project being assessed.

Determining the Overall Level of Effects

---

[5] The life of the statutory planning document or unimplemented resource consents

The landscape and visual effects assessment concludes with an overall assessment of the likely level of landscape and visual effects. This step also takes account of the nature of effects and the effectiveness of any proposed mitigation.

This step informs an overall judgement identifying what level of effects are likely to be generated as indicated in Table 4 below. This table which can be used to guide the level of landscape and visual effects uses an adapted seven-point scale derived from NZILA's Best Practice Note.

	Effect rating	Use and definition
More than minor	**Very high**	Total loss of key elements / features / characteristics, i.e. amounts to a complete change of landscape character
· · ·	**High**	Major modification or loss of most key elements / features / characteristics, i.e. little of the pre-development landscape character remains. Concise Oxford English Dictionary Definition High: adjective- Great in amount, value, size, or intensity
· · ·	**Moderate to high**	Modifications of several key elements / features / characteristics of the baseline, i.e. the pre-development landscape character remains evident but materially changed.
· · · · ·	**Moderate**	Partial loss of or modification to key elements / features / characteristics of the baseline, i.e. new elements may be prominent but not necessarily uncharacteristic within the receiving landscape. Concise Oxford English Dictionary Definition Moderate: adjective- average in amount, intensity, quality or degree
Minor ·	**Moderate to low**	Minor loss of or modification to one or more key elements / features / characteristics, i.e. new elements are not prominent or uncharacteristic within the receiving landscape.
· · · · ·	**Low**	No material loss of or modification to key elements / features / characteristics. i.e. modification or change is not uncharacteristic and absorbed within the receiving landscape. Concise Oxford English Dictionary Definition Low: adjective- 1. Below average in amount, extent, or intensity
Less than minor	**Very low**	Little or no loss of or modification to key elements/ features/ characteristics of the baseline, i.e. approximating a 'no change' situation.

Table 4: Determining the overall level of landscape and visual effects

Determination of "minor"

Decision makers determining whether a resource consent application should be notified must also assess whether the effect on a person is less than minor6[6] or an adverse effect on the environment is no more than minor[7]. Likewise, when assessing a non-complying activity, consent can only be granted if the s104D 'gateway test' is satisfied. This test requires the decision maker to be assured that the adverse effects of the activity on the environment will be 'minor' or not be contrary to the objectives and policies of the relevant planning documents.

These assessments will generally involve a broader consideration of the effects of the activity, beyond the landscape and visual effects. Through this broader consideration, guidance may be sought on whether the likely effects on the landscape resource or effects on a person are considered in relation to 'minor'. It must also be stressed that more than minor effects on individual elements or viewpoints does not necessarily equate to more than minor effects on the wider landscape resource. In relation to this assessment, moderate-low level effects would generally equate to 'minor'.

---

[6] RMA, Section 95E

[7] RMA Section 95D

Appendix H. Archaeological Assessment Report

Archaeological Assessment of the Proposed

Te Ruaotehauhau Water Storage Reservoir

Ohaeawai

1 September 2020

Prepared for:

Te Tai Tokerau Water Trust

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Glossary

Classic	The later period of New Zealand settlement
Midden	The remains of food refuse usually consisting of shells, and bone, but can also contain artefacts
Pa	A site fortified with earthworks and palisade defences
Pit	Rectangular excavated pit used to store crops by Maori
Terrace	A platform cut into the hill slope used for habitation
Wahi tapu	Sites of spiritual significance to Maori

1.0 Introduction

Williamson Water & Land Advisory commissioned Geometria Ltd to undertake an archaeological assessment on behalf of the Te Tai Tokerau Water Trust, of the proposed new Te Ruaotehauhau Water Storage Reservoir west of Ohaeawai.

A number of archaeological sites are recorded in the immediate vicinity of the proposed reservoir, and an even larger number are recorded in the wider area.

Under the Heritage New Zealand Pouhere Taonga Act 2014 (HNZPTA, previously the Historic Places Act 1993), all archaeological sites are protected from any modification, damage or destruction except by the authority of Heritage New Zealand Pouhere Taonga.

This report uses archaeological techniques to assess archaeological values and does not seek to locate or identify wahi tapu or other places of cultural or spiritual significance to Maori. Such assessments may only be made by Tangata Whenua, who may be approached independently of this report for advice.

Likewise, such an assessment by Tangata Whenua does not constitute an archaeological assessment and permission to undertake ground disturbing activity on and around archaeological sites and features may only be provided by Heritage New Zealand Pouhere Taonga, and may only be monitored or investigated by a qualified archaeologist approved through the archaeological authority process.

1.1 The Heritage New Zealand Pouhere Taonga Act 2014

Under the Heritage New Zealand Pouhere Taonga Act 2014 (HNZPTA; previously the Historic Places Act 1993) all archaeological sites are protected from any modification, damage or destruction except by the authority of the Historic Places Trust. Section 6 of the HNZPTA defines an archaeological site as:

> " *any place in New Zealand, including any building or structure (or part of a building or structure), that—*
>
> > *(i) was associated with human activity that occurred before 1900 or is the site of the wreck of any vessel where the wreck occurred before 1900; and*
> >
> > *(ii) provides or may provide, through investigation by archaeological methods, evidence relating to the history of New Zealand; and*
>
> *(b) includes a site for which a declaration is made under section 43(1)"*

To be protected under the HNZPTA an archaeological site must have physical remains that pre-date 1900 and that can be investigated by scientific archaeological techniques. Sites from 1900 or post-1900 can be declared archaeological under section 43(1) of the Act.

If a development is likely to impact on an archaeological site, an authority to modify or destroy this site can be sought from the local Heritage New Zealand Pouhere Taonga office under section 44 of the Act. Where damage or destruction of archaeological sites is to occur Heritage New Zealand usually requires mitigation.

Penalties for modifying a site without an authority include fines of up to $300,000 for destruction of a site.

Most archaeological evidence consists of sub-surface remains and is often not visible on the ground. Indications of an archaeological site are often very subtle and hard to distinguish on the ground surface. Sub-surface excavations on a suspected archaeological site can only take place with an authority issued under Section 56 of the HNZPTA issued by the Heritage New Zealand.

1.2 The Resource Management Act 1991.

Archaeological sites and other historic heritage may also be considered under the Resource Management Act 1991 (RMA). The RMA establishes (under Part 2) in the Act's purpose (Section 5) the matters of national importance (Section 6), and other matters (Section 7) and all decisions by a Council are subject to these provisions. Sections 6e and 6f identify historic heritage (which includes archaeological sites) and Maori heritage as matters of national importance.

Councils have a responsibility to recognise and provide for the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, wahi tapu, and other taonga (Section 6e). Councils also have the statutory responsibility to recognise and provide for the protection of historic heritage from inappropriate subdivision, use and development within the context of sustainable management (Section 6f). Responsibilities for managing adverse effects on heritage arise as part of policy and plan preparation and the resource consent processes.

2.0 Location

The Te Ruaotehauhau Water Storage Reservoir is located across several properties located between Hariru Road, Remuera Settlement Road, and State Highway One, to the west of Ohaeawai. The dam structure will straddle two lots, being Lot 2 DP 442506 and the Okako Block.

The impounded water will extend across the properties mentioned above as well as Section 12S and 16S Remuera Settlement to the west of the dam wall.

3.0 Proposed Development

The purpose of the reservoir is to provide a secure source of irrigable water for horticulture and non-ruminant agricultural use within the mid-north region. It is one of several options identified by the Northland Water Storage and Use Project (NWSUP): Pre-feasibility Demand Assessment and Design Study.

This location was initially short-listed due to its central location within and elevated above the mid-north command area, geological setting, and proximity to Lake Omapere among other criteria. The current proposal is for a 400m long embankment dam up to 21m high and capable of storing 1.4Mm3 at full supply level. Only the central 50m portion of the dam would be 10-20m high, with the majority of the length being less than 10-20m.

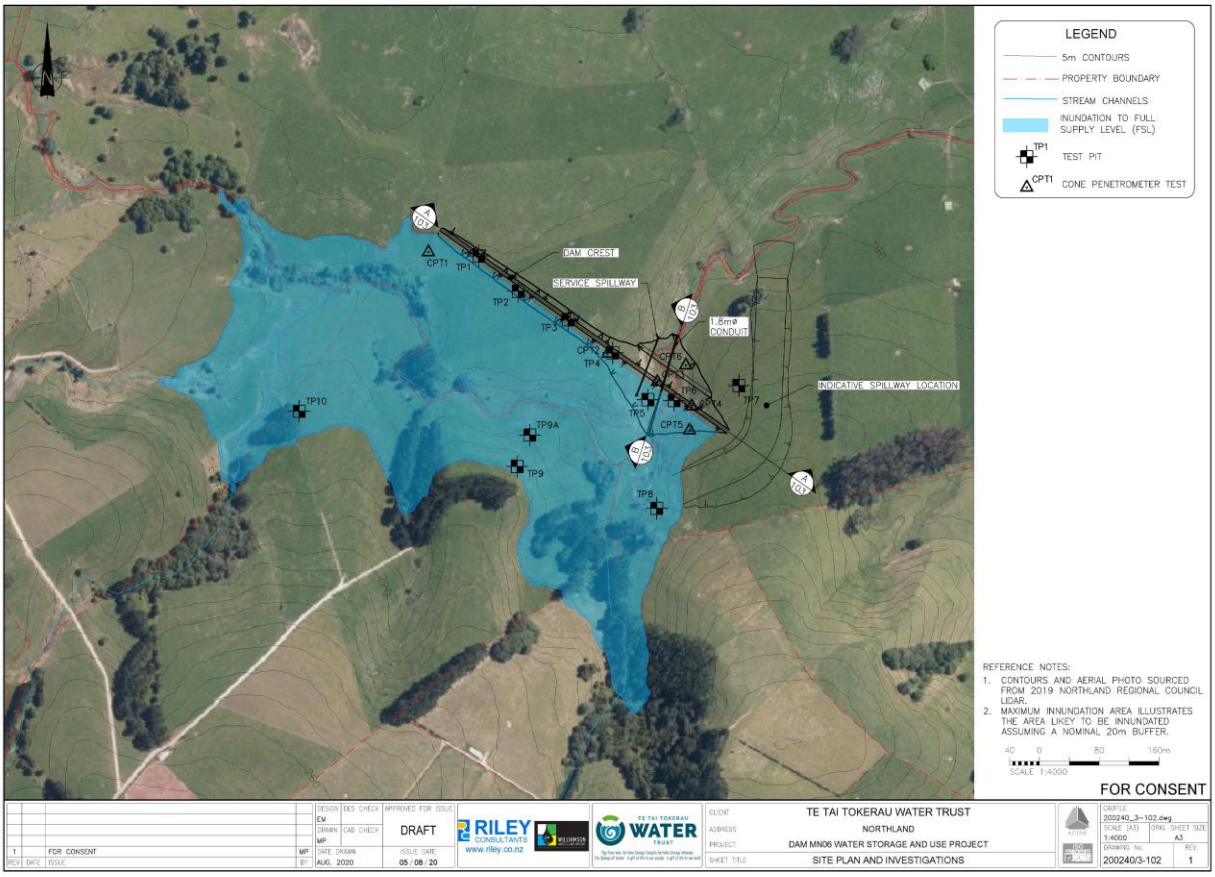


Figure 1: Te Ruaotehauhau Water Storage Reservoir (Riley Consultants 2020).

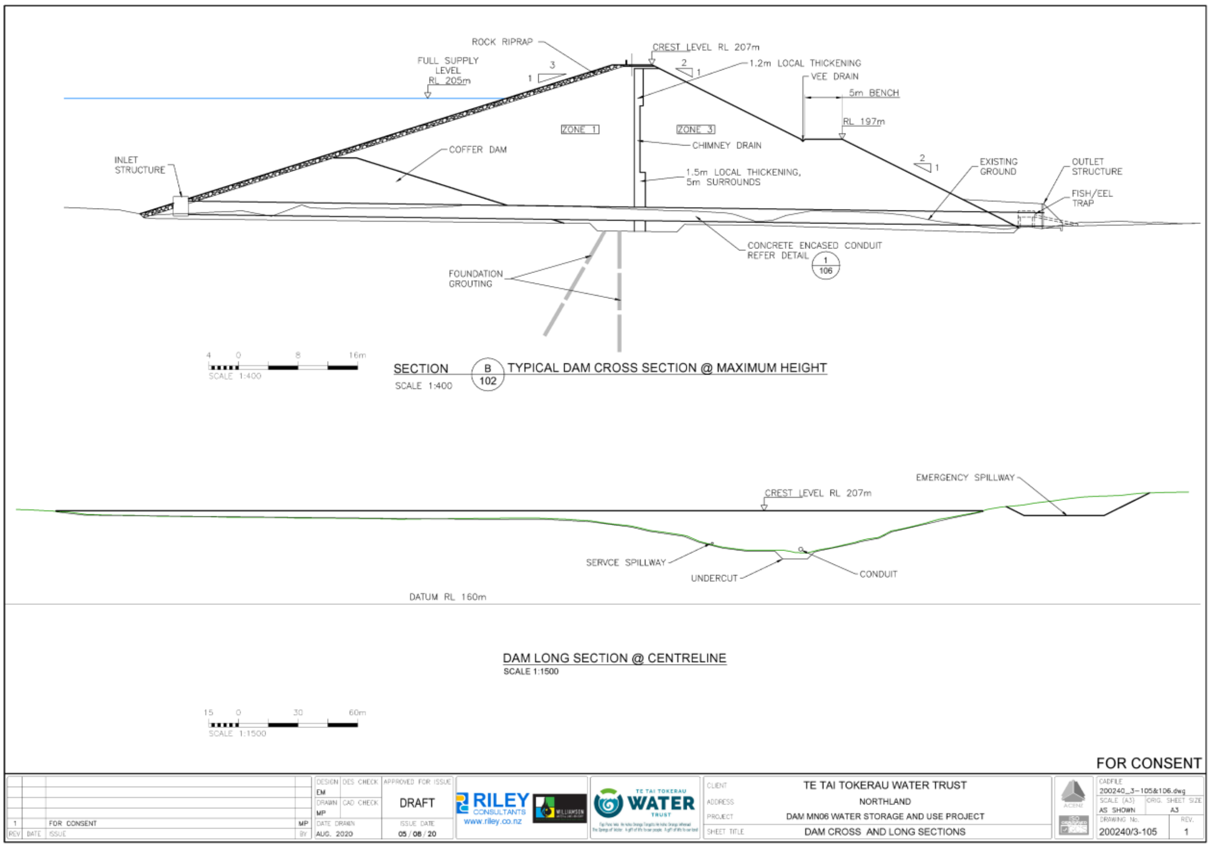


Figure 2: Typical dam cross- and long sections (Riley Consultants 2020).

4.0 Methodology

4.1 Desktop and Field Assessment

The methods used to assess the presence and state of archaeological remains in the project area included both a desktop review and field survey. The desktop survey involved an investigation of written records relating to the history of the property. These included regional archaeological publications and unpublished reports, New Zealand Archaeological Association Site Record Files (NZAA SRF - ArchSite - www.archsite.org.nz - is the online repository of the NZAA SRF), land plans held at Land Information New Zealand, and maps and plans held by other public institutions.

The field assessment involved walking over the project area with a concentration on ridges, spurs and stream banks, and examining eroded or exposed ground surfaces. No probing or test pitting was undertaken given the size of the project area and the obvious surface features making such testing inappropriate.

4.2 Significance Assessment

Where archaeological sites, features and/or values are present in the vicinity of the proposed track improvements, two sets of criteria are used to assess their significance:

The first set of criteria assess the potential of the site to provide a better understanding of New Zealand's past using scientific archaeological methods. These categories are focussed on the intra-site level.

How complete is the site? Are parts of it already damaged or destroyed? A complete, undisturbed site has a high value in this section, a partly destroyed or damaged site has moderate value and a site of which all parts are damaged is of low value.

How diverse are the features to be expected during an archaeological excavation on the site? A site with only one or two known or expected feature types is of low value. A site with some variety in the known or expected features is of moderate value and a site like a defended kainga which can be expected to contain a complete feature set for a given historic/prehistoric period is of high value in this category.

How rare is the site? Rarity can be described in a local, regional and national context. If the site is not rare at all, it has no significance in this category. If the site is rare in a local context only it is of low significance, if the site is rare in a regional context, it has moderate significance and it is of high significance it the site is rare nationwide.

The second set of criteria puts the site into its broader context: inter-site, archaeological landscape and historic/oral traditions.

What is the context of the site within the surrounding archaeological sites? The question here is the part the site plays within the surrounding known archaeological sites. A site which sits amongst similar surrounding sites without any specific features is of low value. A site which occupies a central position within the surrounding sites is of high value.

What is the context of the site within the landscape? This question is linked to the one above, but focuses onto the position of the site in the landscape. If it is a dominant site with many features still visible it has high value, but if the position in the landscape is ephemeral with little or no features visible it has a low value. This question is also concerned with the amenity value of a site and its potential for on-site education.

What is the context of the site within known historic events or people? This is the question of known cultural association either by tangata whenua or other descendant groups. The closer the site is linked with important historic events or people the higher the significance of the site. This question is also concerned with possible commemorative values of the site.

An overall significance value derives from weighing up the different significance values of each of the six categories. In most cases the significance values across the different categories are similar.

5.0 Archaeology and History

5.1 Archaeological Sites and Context

5.1.1 Archaeological Context

In general site density in the vicinity of the project area is low, in part because of the lack of survey south of State Highway 1 and east of Hariru Road. However in areas which have been surveyed nearby, site density is relatively high and appears to coincide with areas of highly productive soils around Lake Omapere and Te Ahuahu, Maungakawakawa and Tarahi volcanic cones.

Slane and Grant (1980) undertook a large scale reconnaissance survey of the country between State Highway 1 and State Highway 12 and Lake Omapere, from Old Bay Road in the east to Te Pua Road in the west. While they survey they originally proposed was to encompass the entire area, subsequently they undertook survey around the eastern shore of the Lake, Putahi and Waimitimiti craters. Their final survey did not include the project area however they made a number of general comments regarding site distribution and environment that are pertinent.

From Te Pua Road east to Ohaeawai they noted the land had mostly been cleared of evidence of Maori horticulture (stone clearance and gardening mounds, stone rows and alignments etc) by European farming including ploughing, discing and draining, but stated that many farmers had collections of stone and wooden artefacts. Little evidence of Maori occupation otherwise remained apart from earthworks on the volcanic cones and the occasional stone mound on top of a basalt outcrop that was too difficult for farmers to move.

Elsewhere on the nearby areas with similar underlying Taheke and Horeke basalts, farming and farm development had been less intensive and with the exception of Putahi and Tarahi to the west and south of the project area respectively, contained large numbers of archaeological features. The alluvial flats around the lake had little surface evidence of occupation but large numbers of wooden artefacts have been discovered in the water and on the shoreline.

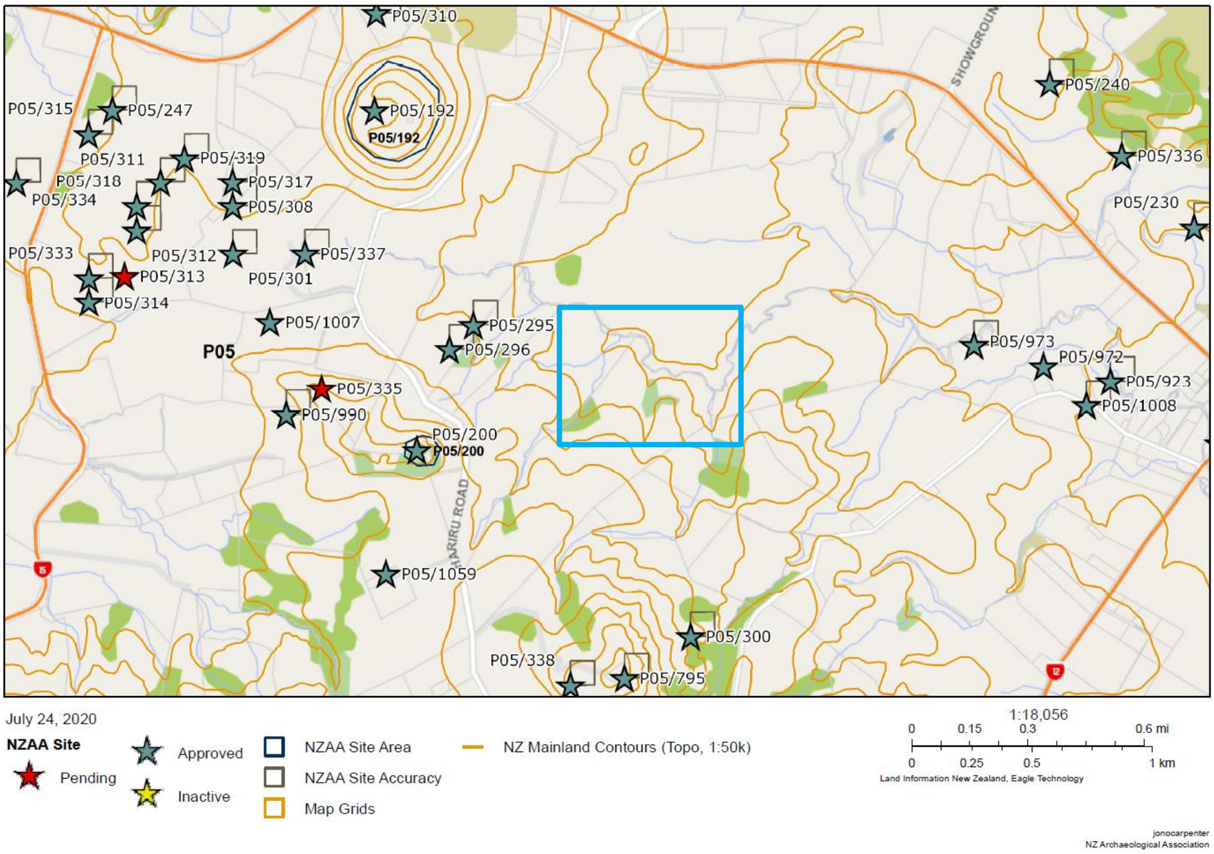


Figure 3: Recorded archaeological sites in the vicinity of the proposed reservoir (in blue).

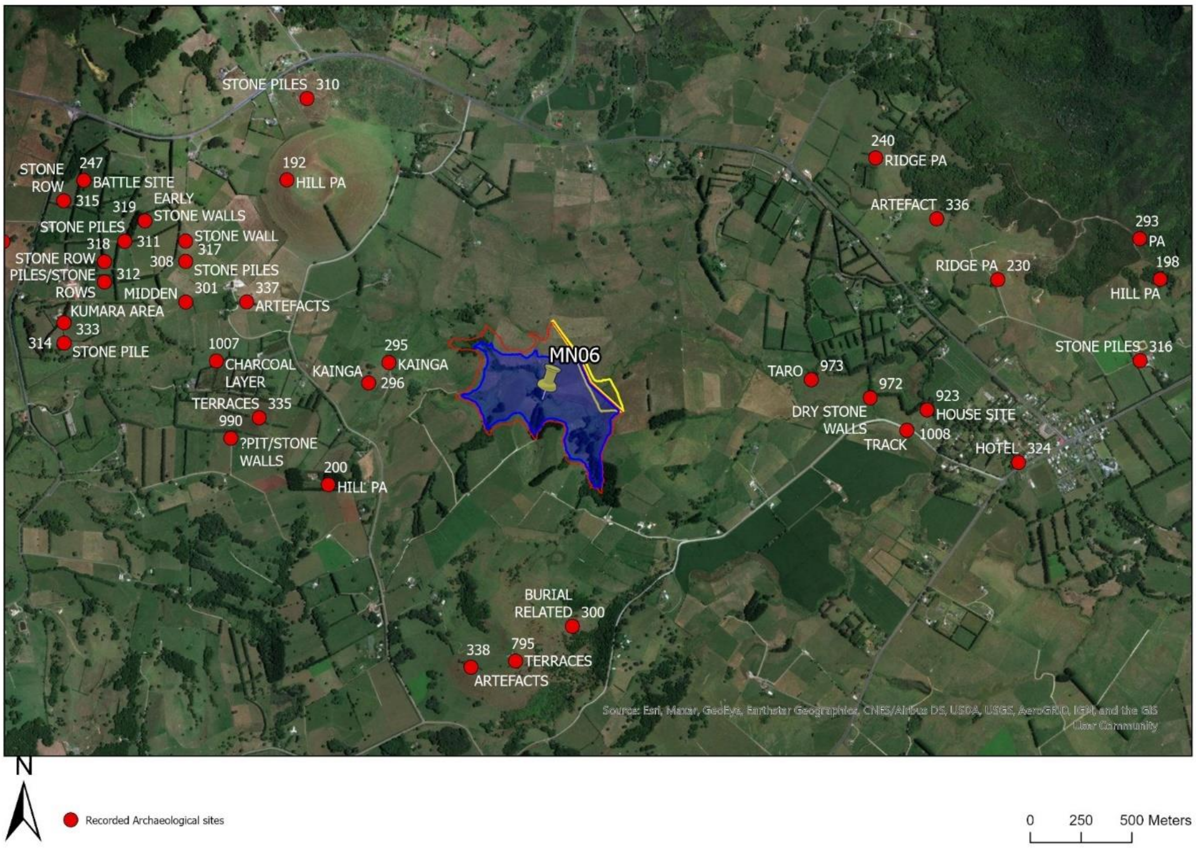


Figure 4: Recorded archaeological sites by site type.

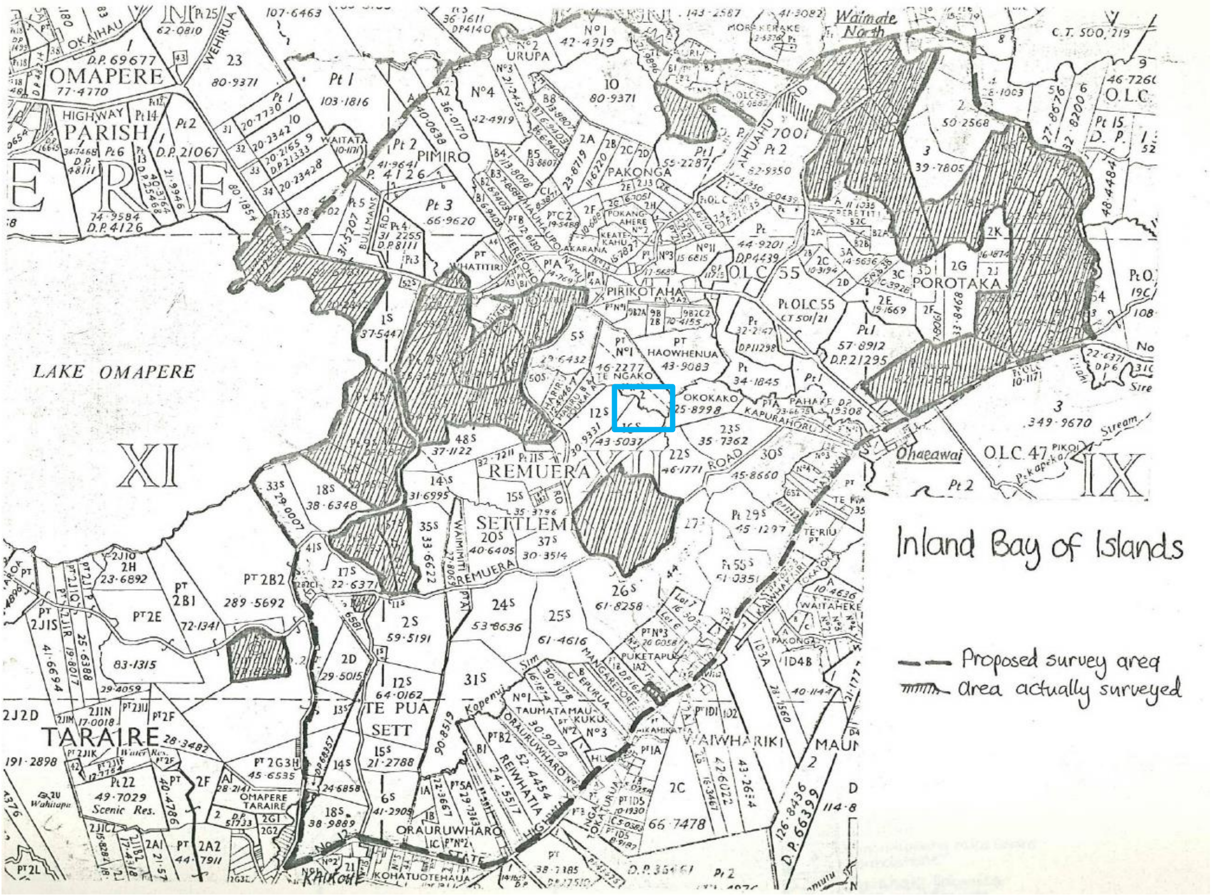


Figure 5: Slane and Grant (1980: 1) proposed and actual site survey (project area in blue).

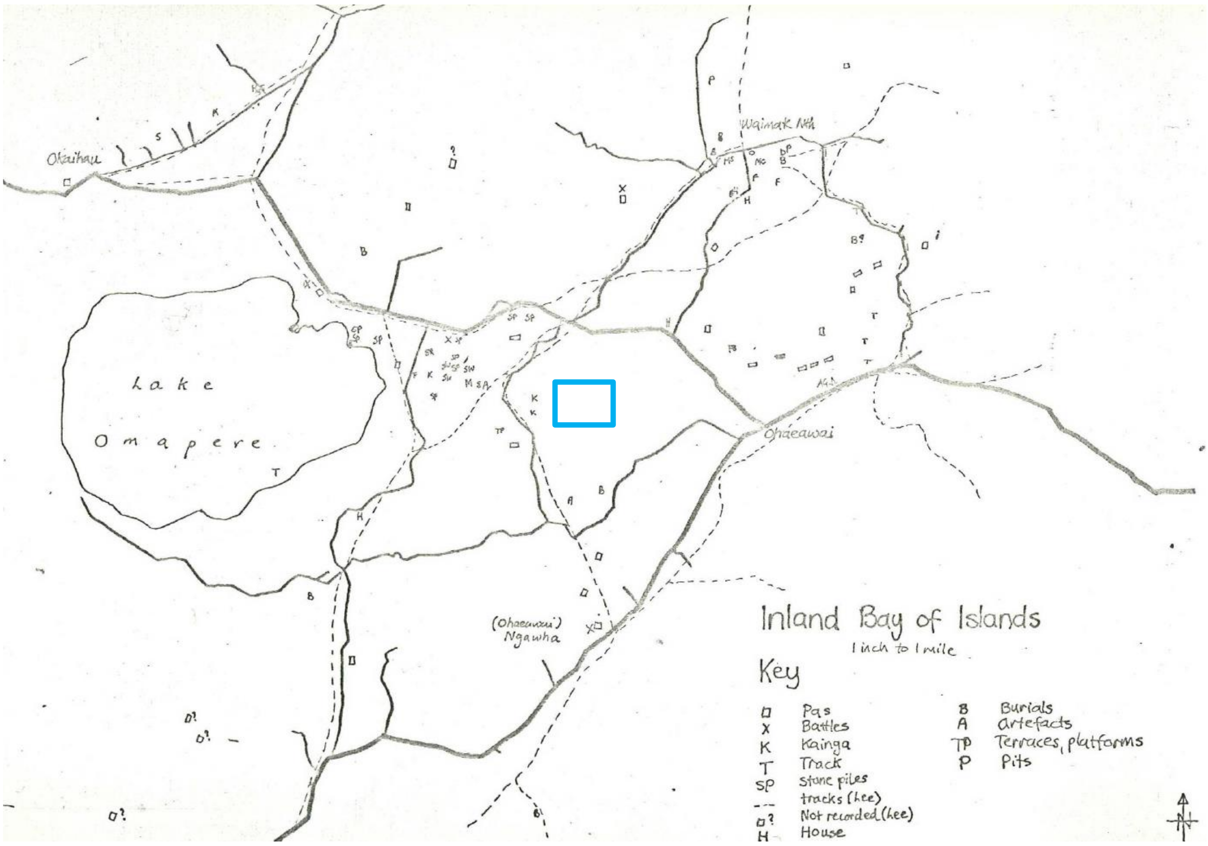


Figure 6: Site distribution by type (Slane and Grant 1980).

5.1.2 Archaeological Sites in the Vicinity of the Project Area

Slane and Grant recorded two archaeological sites immediately west of the western side of the reservoir. These are two kainga or undefended settlements recorded as P05/295 and P05/296 (N15/154 and N15/156 respectively, in the original Imperial map sheet recording system), located on the Hariru Block. These sites are approximately 400m west of the reservoir.

P05/295 and P05/296 were two kainga recorded on the Hariru Block survey plan drawn up by R. C. Davis in 1868. The survey plan shows two areas delineated by dashed rectangles labelled "Kainga", with small triangles drawn inside the rectangles. The rectangles are located on the eastern boundary of the block, below the track from Waimate North to Ohaeawai and the highpoint then referred to as Pukepoto/Kawakawa (i.e. Maungakawakawa).

The sites were revisited by A. Middleton in 2014, in the company of Gil Parker. The site of both P05/295 and P05/296, kainga, is the same place where Gil Parker reported that his grandmothers house once stood. This house was built by his great grandfather, Hare Matenga, but it burnt down in 1948. Remains of the house can be seen beneath the stand of macracarpa trees - concrete, bricks and metal, probably the remains of the chimney at Easting 1676695 Northing 6087900 (NZTM).

Middleton reports that there were also burials associated with this site, beneath the stones to the west while the puriri trees further away towards Tarahi pa (only one or two remaining) is where bodies were once left before their secondary burial. Gil Parker gave her the name of the pa, Taurangatira, which was not a defended pa but more like a kainga. Hare Matenga put an end to burials there and then built the house.

The two kainga P05/295 and P05/296 were located close together, as the Davis plan 948 shows; the track to P05/295 must pass over the vicinity of P05/296, however Middleton saw no apparent surface features relating to this. She states that Gill Parker was particularly clear about the name Taurangatira and that it is likely to have related to both kainga, given their close location.

The next nearest site is Maungakawakawa itself, P05/200, and at Tarahi P05/795 and the other sites associated with those pa/maunga. A large number of sites are recorded further to the west and north west around Te Ahuahu and Lake Omapere, and to the east at Ohaeawai. These sites include features associated with pre- and protohistoric Maori horticulture such as stone gardening mounds, 19th century or later dry stacked stone walls, pa sites and terrace complexes, and burials.

5.1.3 Other Heritage Listings

There are no sites of significance to Maori, historic places or other scheduled items in the Far North District Plan, or listed heritage places in the Heritage New Zealand Pouhere Taonga List, within the project area.

Te Ahuahu, Maungakawakawa and Tarahi are significant landscape features and sites of significance to Maori scheduled in the Far North District Plan. There scheduling is as follows:

Te Ahuahu (MS 09-04; Outstanding natural feature 67)

Hariru (MS 09-27; Outstanding natural feature 29)

Tarahi (Outstanding natural feature 59)

Dry stacked stone walls also have controls in the Far North District Plan.

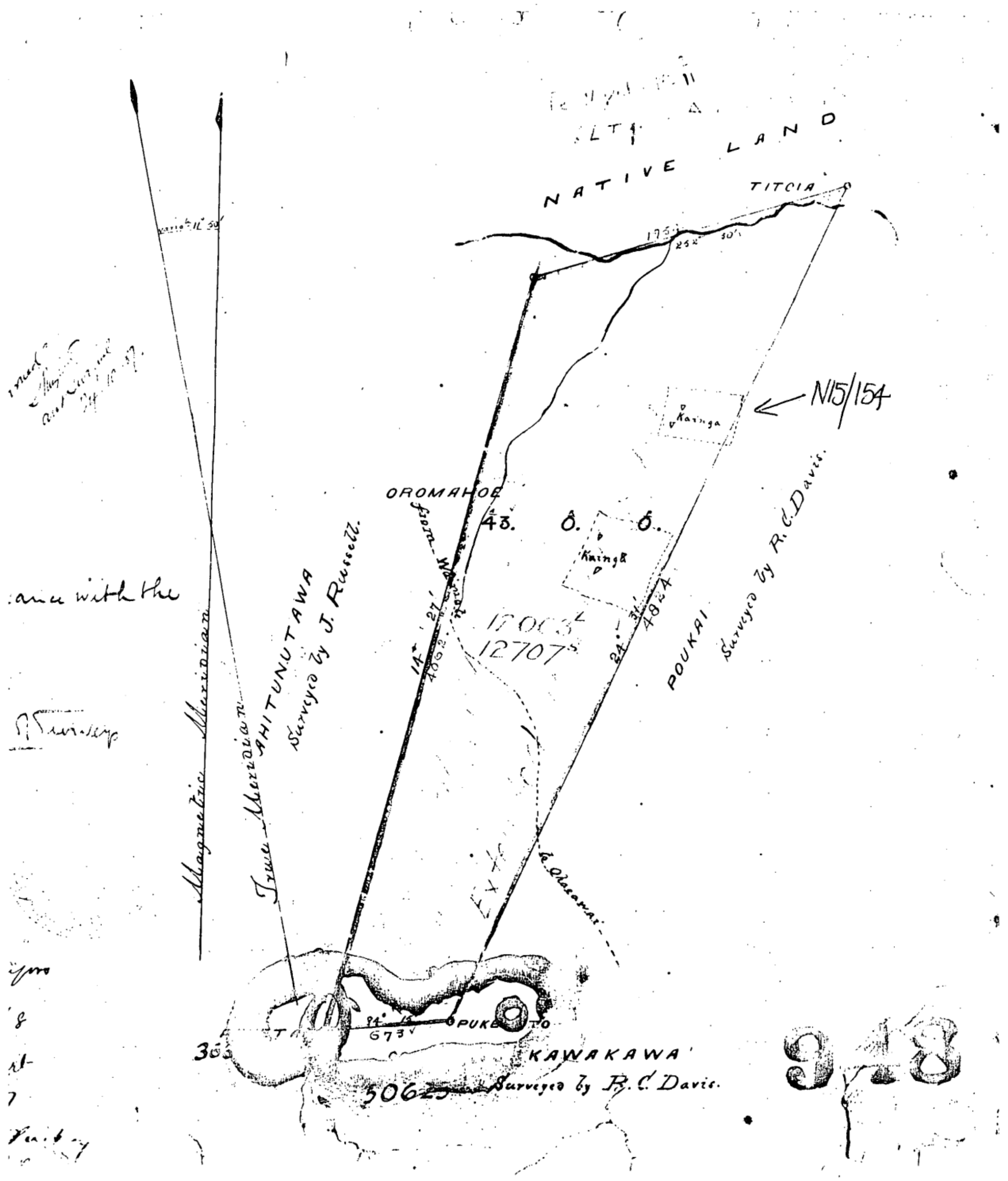


Figure 7: Detail from ML 948 Plan of the Hariru Block, with kainga indicated.

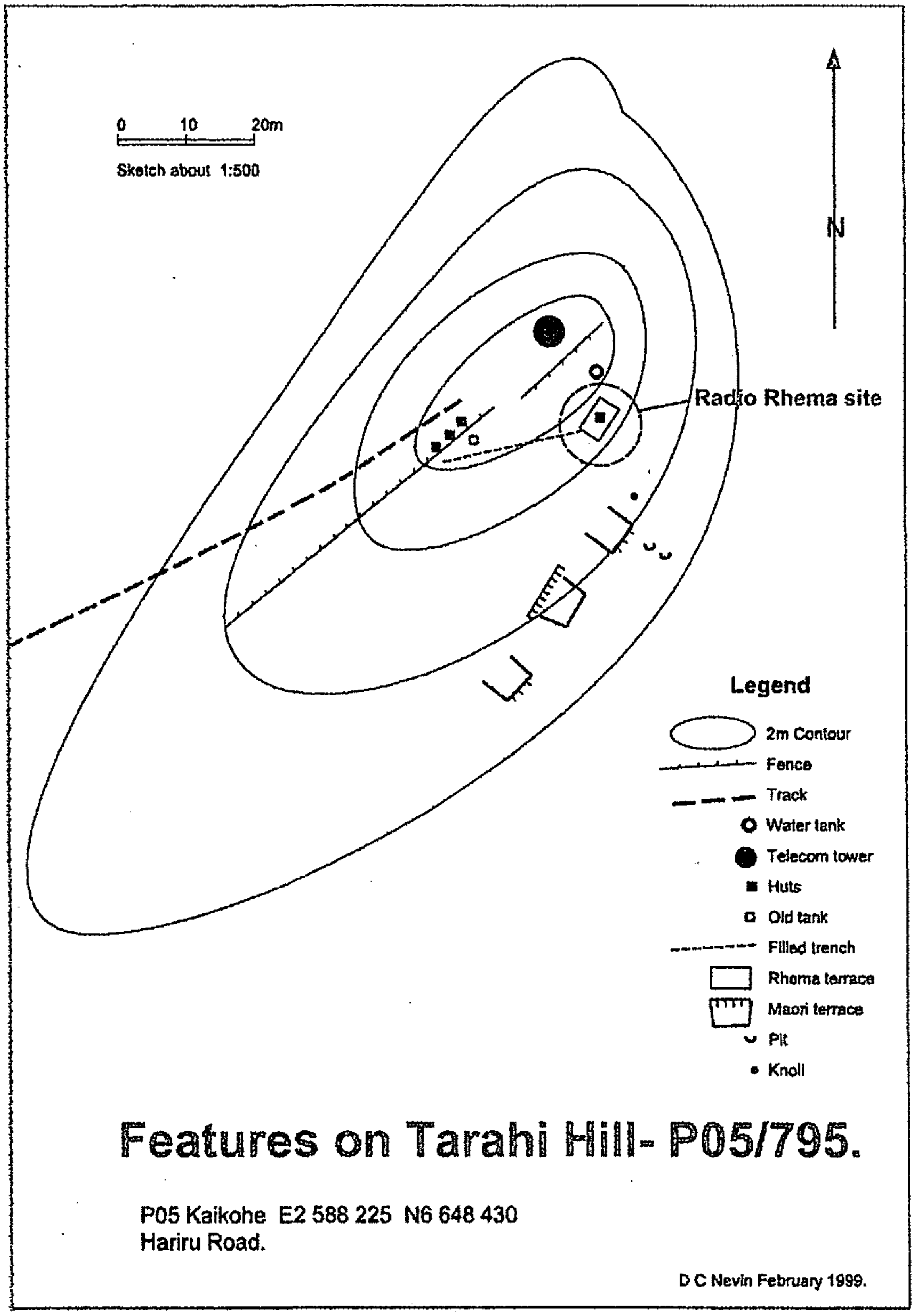


Figure 8: P05/795, Tarahi.

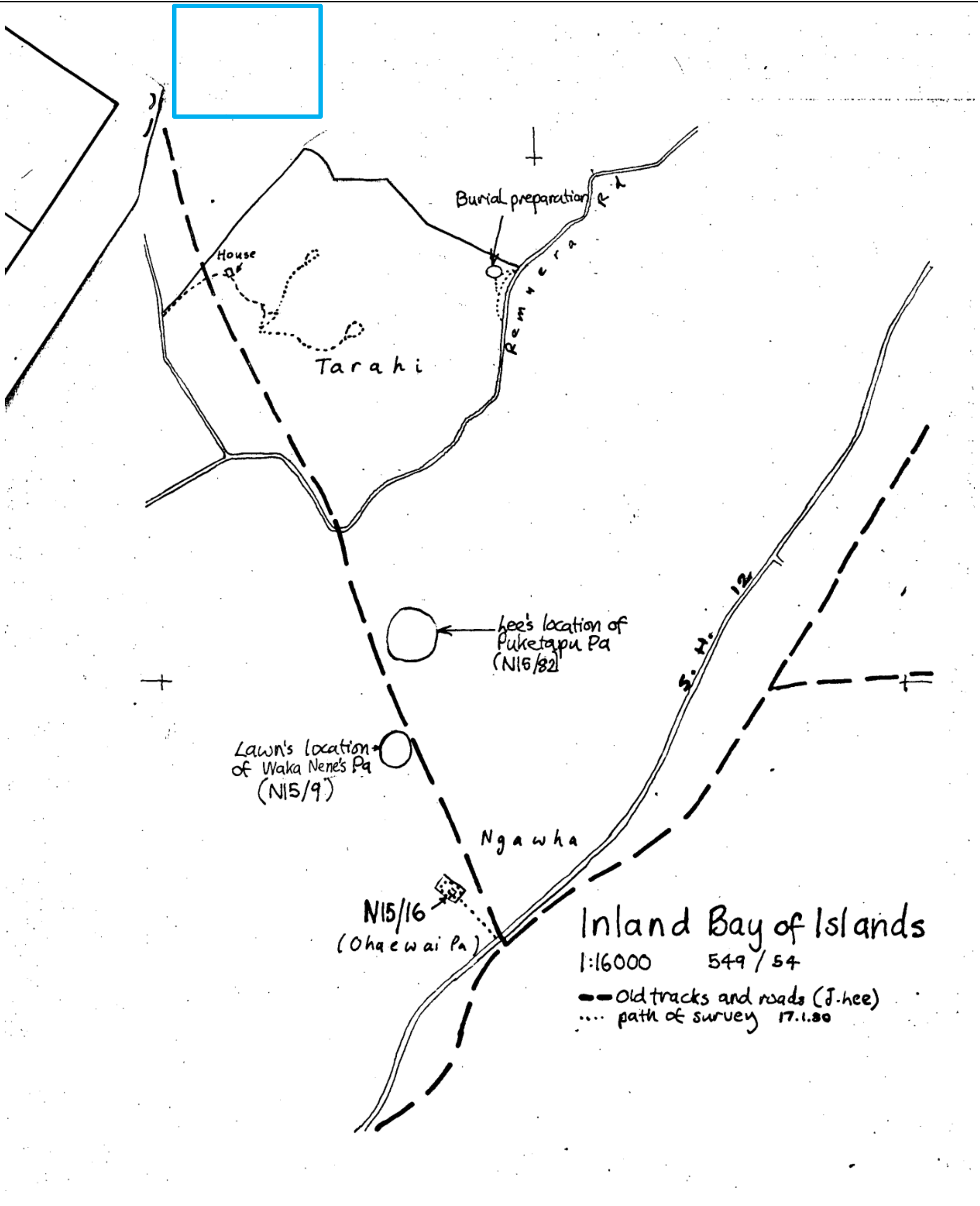


Figure 9: Sites between the project area and Ngawha.

5.2 Historic Background

The Te Ahuahu-Ohaeawai-Kaikohe-Waimate North area was an important area of pre-Contact Maori settlement, and European/Maori interaction in the 19th century. The area was also the site of a major battle of the Northern War of 1845-46, between forces allied with the British under Tamati Waka Nene, and those of Hone Heke. The wider landscape is highly archaeologically, historically and culturally significant.

The history of the area is intimately tied to the spread and consolidation of inland iwi/hapu from the Taimai area eastwards to the coastal areas of what is now the Bay of Islands, in the late 18th and early 19th centuries. In the mid 18th century the area around Te Ahuahu was the domain of Ngati Pou, who came under increasing pressure from the Taiamai people.

The following account is taken from (Sissons et. al. 1987: 27, 30, 34). Whaingaroa, was a leading rangatira of the Taiamai hapu Ngare Hauata and is known today as an important Ngati Hine ancestor. Traditions Whaingaroa, in alliance with Kaitara of Ngati Hineira, and Matahaia of Ngati Rangi defeated the former Ngati Pou, in the 1790s, after which they left the area for the Hokianga and Whangaroa. Kaitara came to settle at Te Ahuahu and married a Ngati Pou woman, Inu.

Wiremu Katene, a great-grandson of Kaitara stated that after the conquest the land was divided into three blocks, first of which was for Whaingaroa (at Pakaraka) [East Taiamai], second to Matahaia at Ohaeawai [West Taiamai], and from Mr. Ludbrook's residence [between Ohaeawai and Pakaraka] to Omapere was allotted to Kaitara [north and north-west of Taiamai] (Maori Land Court Northern Minute Book 5:7).

Kaitara came to live at a settlement called Pukenui, at the foot of Te Ahuahu, and was visited there by a number of early European travellers through the area including Samuel Marsden, Thomas Kendall and Captain Cruise. Marsden noted that the land between Pukenui and Taiamai was the best he had ever seen, and the sides of the hill were under potato cultivation when he visited in 1820. Later, the CMS missionaries from Waimate would include services at Pukenui in their weekly or fortnightly rounds, noting that they could serve 3000-5000 Maori within a five mile circuit.

The principal hapu at Te Ahuahu at that time was probably Ngati Hineira, although the missionaries also met there a Ngati Pou rangatira, Tiiohu. Given Kaitara's wife, Inu, belonged to Ngati Pou, it is possible that after the Taiamai battles some of her relatives had returned to Te Ahuahu to reside there with Ngati Hineira. Tiiohu's father, Te Maunga, was a leading Ngati Pou rangatira at the time of the Taiamai battles, and had occupied Maungaturoto pa. Tiiohu's mother, Puhirangi, was closely related to Kaitara's wife, both of whom were descendants of Rangihaua, the founding ancestor of Ngati Pou.

To the south west of the project area, Kaikohe itself was originally known as Opango, before being renamed after a historic raid by an enemy taua in the early 19th century required the inhabitants to flee to the forest on Tokareireia (Kaikohe Hill) and subsist amongst the Kohekohe trees. By the mid-19th century, the area boasted a Church Mission Society mission along with its Maori inhabitants. To the south east, at Ngawha/old Ohaeawai, the British suffered their worst defeat in the first New Zealand war, in July 1845. Maps from this area show battle sites, Pa, kainga, mission stations, foot and cart tracks and important rivers, streams, mountains and wetlands. Nothing is shown in the project area.

The Te Ngako II Block (ML 2690) was surveyed in 1872 and the Te Ngako I Block (ML 2689) was surveyed in 1873. Both surveys show the name of the stream as Te Rua o te Houhou, which flows into the Pekapeka Stream. In 1905, the western end of the Te Ngako I and II Blocks adjacent to Harimembers Road was subdivided off the balance, as shown on DP 3601, and all the land is annotated with the name Marsden Clarke. Marsden Clarke was a son of George Clarke (Senior), CMS missionary and Protector of

Aborigines. Marsden was born in 1837 at Waimate and died there in 1889, suggesting the Marsden on the survey plan was a son or other relative.

The Okokako Block of 64 ha on the southern side of the project area was surveyed in 1867 (ML 453, 1867). At that time, the land to the north and west was still in Maori ownership, while the land to the north east belonged to William Clarke, with the Kapurahoru Block to the south. William was also a son of George Clarke Senior, born in 1827 and dying in 1914.

The Poukai Block was surveyed in 1896 (ML 947 A 1). Along with the stream named Te Rua o te Hou Hou, it shows the point of the stream at the boundary of the Poukai and Hariru Blocks as Titoia, with the point on the stream at the boundary with the Maungakawakawa Block named Te Rotohau, and on the north side of the stream on the Te Ngako side, the name Waiparataniwha. By the 1930s, these blocks had been broken, fenced, and were in a mix of ploughed lands, pasture and fern (SO 20519).

After World War One, the land on the south side of the stream was incorporated into Blocks 12S, 16S and 22S of the Remuera Special Settlement scheme.

The Remuera Special Settlement Scheme, established at the end of the World War One. The Remuera Special Settlement was established for veterans under the Discharged Soldiers' Settlement Act, and which included the project area. The Act allowed the Crown to purchase large, improved estates to subdivided for the benefit of returned servicemen. The land was purchased by the Crown and had been subdivided for the settlement by June 1919, prior to which it had been owned by settlers Messrs Close and Dickson, and Messrs Pithcaithly and Wright (Auckland Star, 6 June 1919).

Johnson and Callaghan (2020: 7), quoting an earlier unpublished report (Johnson and Callaghan 2014) state:

> "With regard to the Remuera Settlement it is understood that Arthur Close and George Dickeson purchased large areas of Maori land and other small farms in this area, prior to WWI (Bradnam 2003). Arthur Close was from Remuera in Auckland-and the 'Remuera Estate' comprising some 3500acres, was named after that suburb. The Estate was farmed, running a Romney Marsh stud and Hereford Cattle. It would appear that at some point between 1911 and 1919 further 'blocks' of land were purchased and incorporated into the 'Remuera Estate'. After World War I, Close and Dickeson were approached by the New Zealand Government for 'compulsive land purchase'. The 'Remuera Settlement' which comprised the 'Remuera Estate' and 'Omapere Farm' (owned by Messrs Wright and Pitcaithly) was divided and sold/leased in 1919 under the Discharged Soldiers Settlement Act (1915).

The opening up of the land was advertised in newspapers in September 1919, with 3553 acres in 31 sections from 70 to 372 acres in size available, valued at £63,000. The land was described as 'First-class" or "Improved", "…ranging from fair to the very best quality", and 40 applicants submitting ballots for the land. Applicants were interviewed by the Auckland Land Board (Taihape Daily Times, 30 August 1919; Auckland Star, 17 September 1919).

However the land was undersubscribed and two weeks after balloting closed, almost half the lots were still available and only 16 men had taken up land there. One suggestion for the lack of interest was the remoteness of the block making it difficult for prospective purchases to inspect the land, but the Auckland Land Board suggested that locals had been running down the quality of the land to prospective purchasers, and putting them off buying there (Auckland Star, 6 October 1919).

Remuera Block sections continued to sell slowly into the early 1920s, with the potential of the land increasing as work was undertaken to lower the level of Lake Omapere (Northern Advocate, 29 January 1921). While hundreds of pounds were spent on roading through the settlement in the mid-1920s, half the settlers (14 of 28) had walked off the land due to the financial and other difficulties (Northern Advocate, 14 March 1928) and the settlers stopped paying rates leading to the deterioration of the Ohaeawai-Lake Omapere road (Northern Advocate, 30 July 1928). The road through the Te Pua and Remuera settlements continued to be a source of frustration, and in the 1929 milking season was so bad that 50,000 pounds of butter fat had to be sledged rather than carted from the settlement to the main highway between Ohaeawai and Okaihau (Northern Advocate, 30 January 1930) and difficulties with the road continued through the 1930s and 1940s.

In its annual report for 1922, the Department of Lands and Survey reported good progress has been made by nearly all the settlers during the year. The settlement was reported to be well established. "About 30 chains of new road had been constructed. The benefit of the lowering of Lake Omapere is now being felt by those settlers occupying the sections on the lake frontage. There were still three vacant sections on the settlement, which should be selected at any time." DEPARTMENT OF LANDS AND SURVEY. DISCHARGED SOLDIERS SETTLEMENT. REPORT FOR THE YEAR ENDED 31st MARCH, 1922. Appendix to the Journals of the House of Representatives, 1922 Session I, C-09

In 1926, the Department reported that the settlers on this block were "…now settling down. Three of the sections were abandoned—one of these has been reselected, and there should be no difficulty in disposing of the others. Some of the sections have been regrouped, and this has made the settlers more contented. At the present time there are twenty settlers all milking and doing well. A road contract has just been completed, which finishes all the roading required at present. Te Pua Settlement. — The five sections on this settlement are all occupied, and all the settlers are getting along satisfactorily, but the land will have to be continually top-dressed to give the best results." DEPARTMENT OF LANDS AND SURVEY. SETTLEMENT OF CROWN LANDS (ANNUAL REPORT ON). Appendix to the Journals of the House of Representatives, 1926 Session I, C-01.

5.2.2 Review of Historic Maps, Plans and Aerials

A review of historic maps and plans for the area was undertaken, and the findings reported on above. More than eighty survey plans for the area were inspected and those showing historic features or other relevant information for the project area were georeferenced into an ArcGIS map project and the features digitised in order to relate their position to the project area.

No specific historic features were identified in the immediate vicinity of the subject property, beyond bush lines, historic place names which have been transferred to land parcels, and old parcel appellations which relate to settlement schemes.

The stream is shown variously as Te Rua o te Hou Hou (or Te Rua o te Hau Hau, or Te Rua o Te Hore Hore (possibly a miscopying of Hou Hou), with points on the stream within the project area named Titoia, Roto Te Hau, Waipara Tanewha, Puketawa and the downstream end of the stream is shown as Pekapeka. Two 19th century kainga are also recorded on the Hariru Block, to the north west of the reservoir, as previously noted.

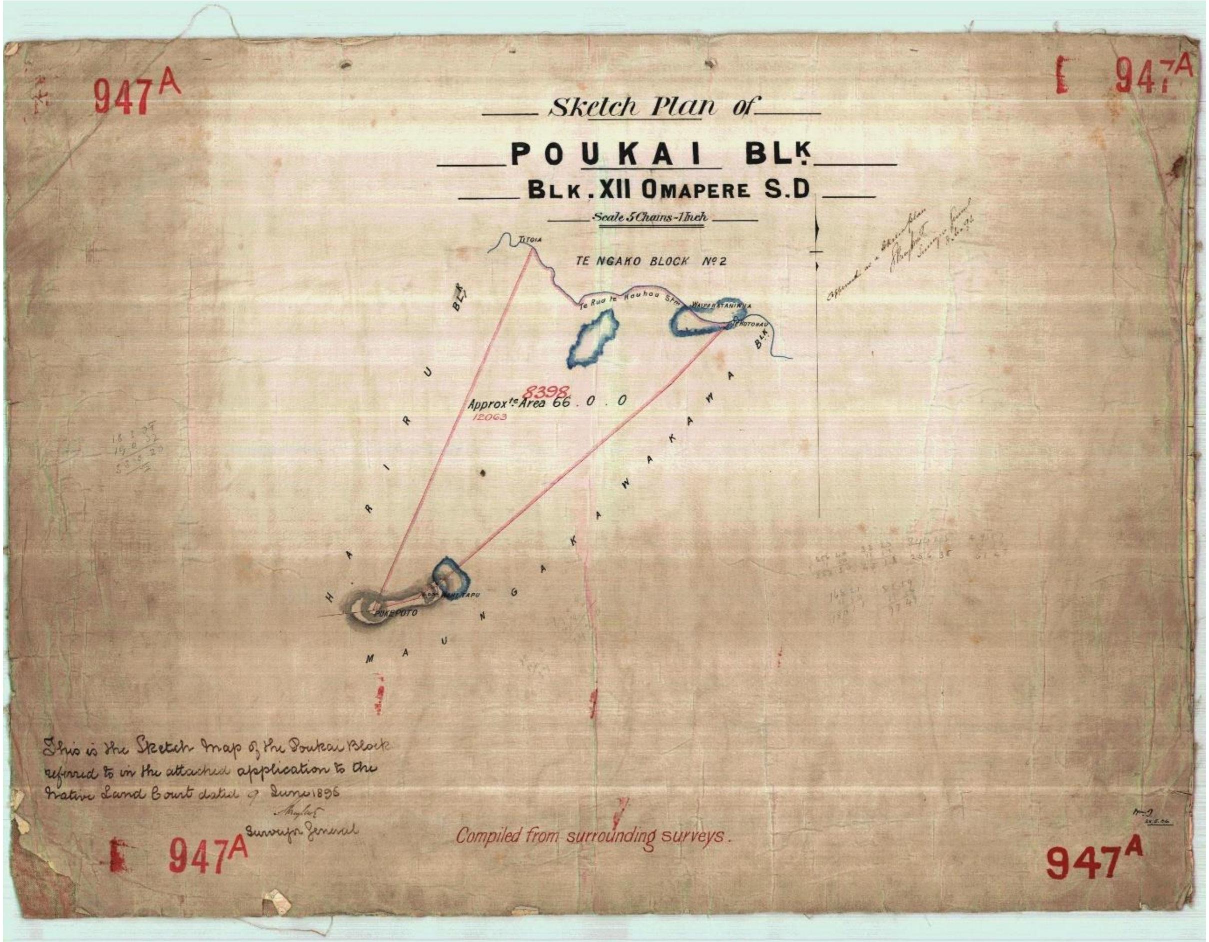
A number of historic names are recorded for the area on historic survey plans. Hariru and Okokako Blocks are still present, but on the south side of the stream the project area lies within what was the Pouakai Block and the. The north side of the project area falls within the Te Ngako Block. Fenced paddocks and a structure are shown on the western side of the Te Ngako Block in 1905. Te Ngako appears to be a short form of Te Ngako o Tuiti, a name shown on the boundary between the Te Ngako and Haowhenua Block to the east, on the survey of that block from 1870 (ML 1918).

A number of other sources were also examined. Several large scale maps of the area were produced during the first New Zealand War of 1845-46 and which show major pa, other settlements, mission stations and geographic features in the wider area but nothing of note in the project area. The Geological Map of the Omapere Survey District (Crawford 1909) likewise shows nothing of note in terms of historic features and neither does the 1942 NZMS 1 mapsheet for Kaikohe.

A review of aerial imagery for the area was undertaken and some potential archaeological or other historic heritage features are apparent. The earliest, 1955 aerial imagery is partly obscured by cloud over the project area but shows what appears to be stone walls, drainage trenches, and potential stone mounds north of the Rua o Te Hau Hau stream.

Figure 10: Detail from 1845 map of Bay of Islands (south is up; project area outlined in blue).

Figure 11: Detail from 1845 campaign map (north east is up; project area outlined in blue).



This is the Sketch map of the Poukai Block referred to in the attached application to the Native Land Court dated 9 June 1896

Surveyor General

Land Information New Zealand, Custom Software Limited, Date Scanned 2002, Last modified March 2002, Plan is probably current as at 29/05/2019

Figure 12: ML 947 (original survey 1868) showing Poukai Block, and names on the stream.

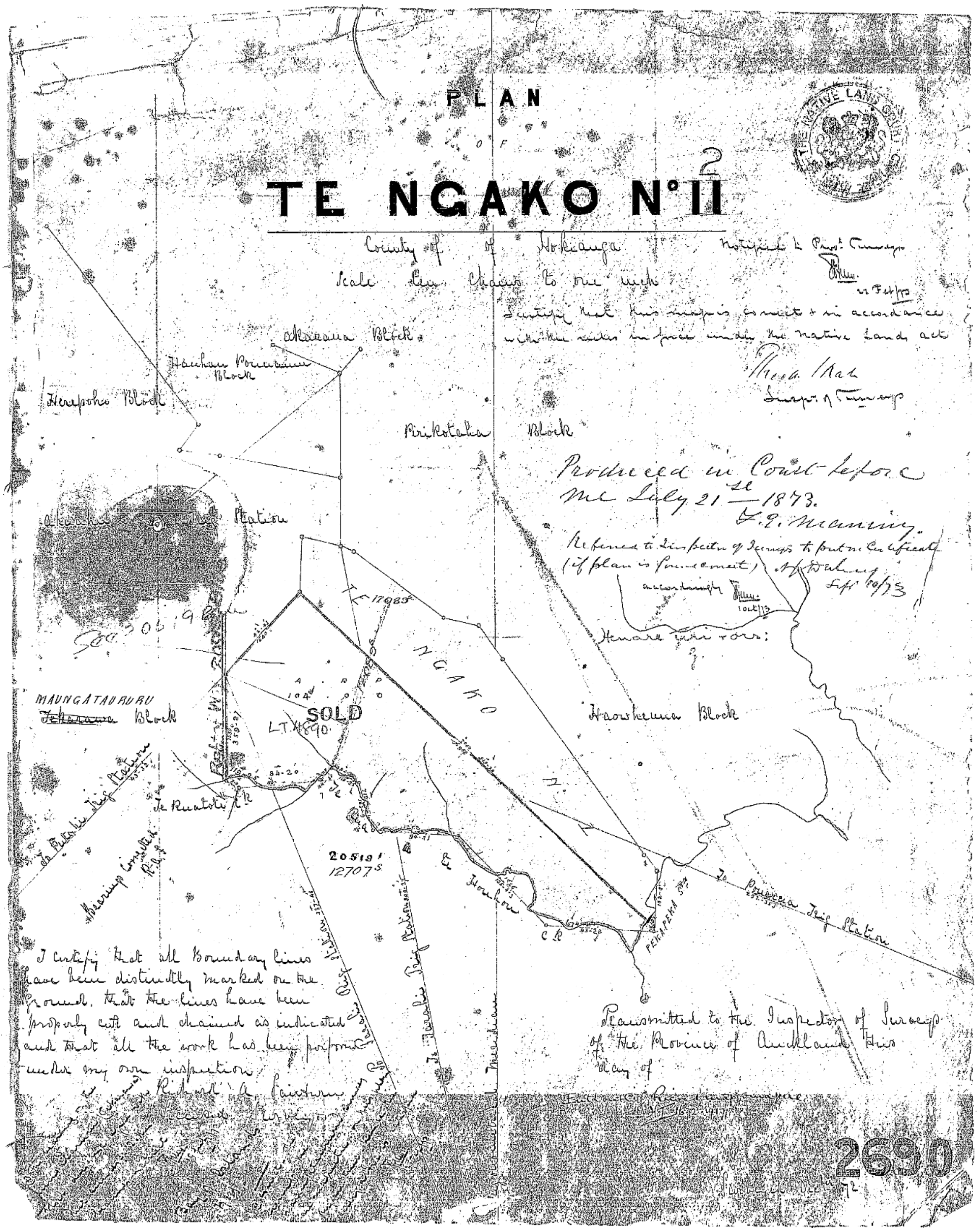


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Figure 13: ML 2690 (1873) Te Ngako I and II Blocks, and names on stream.

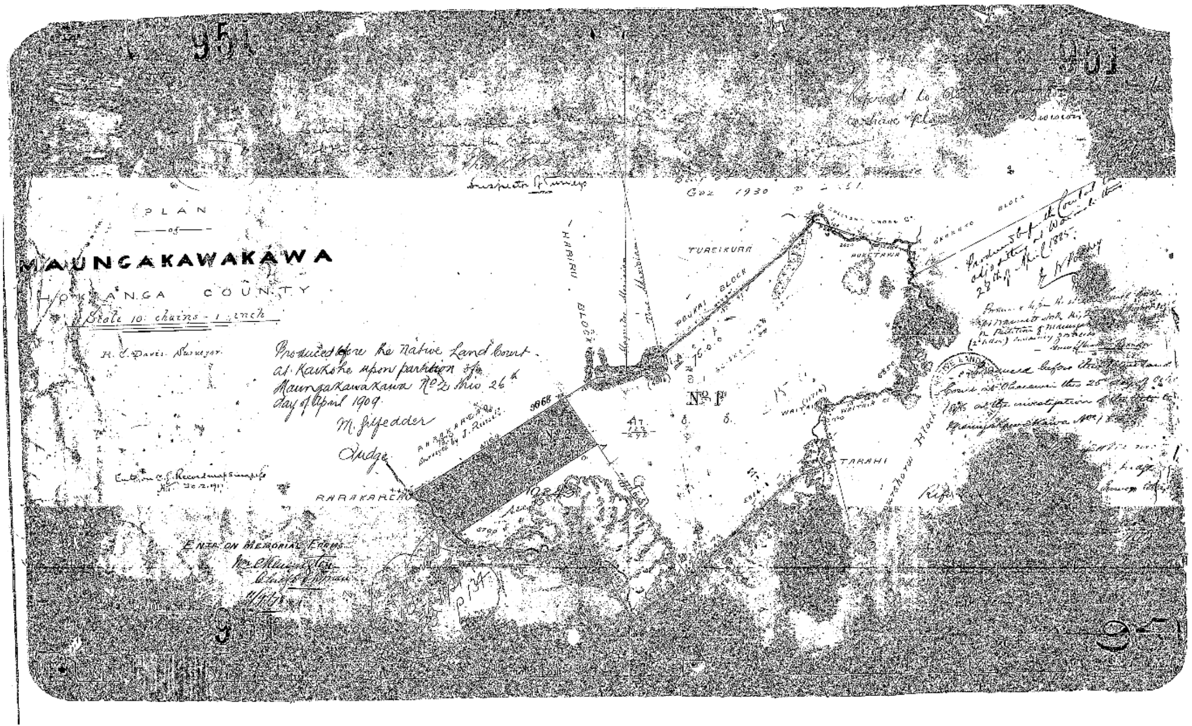

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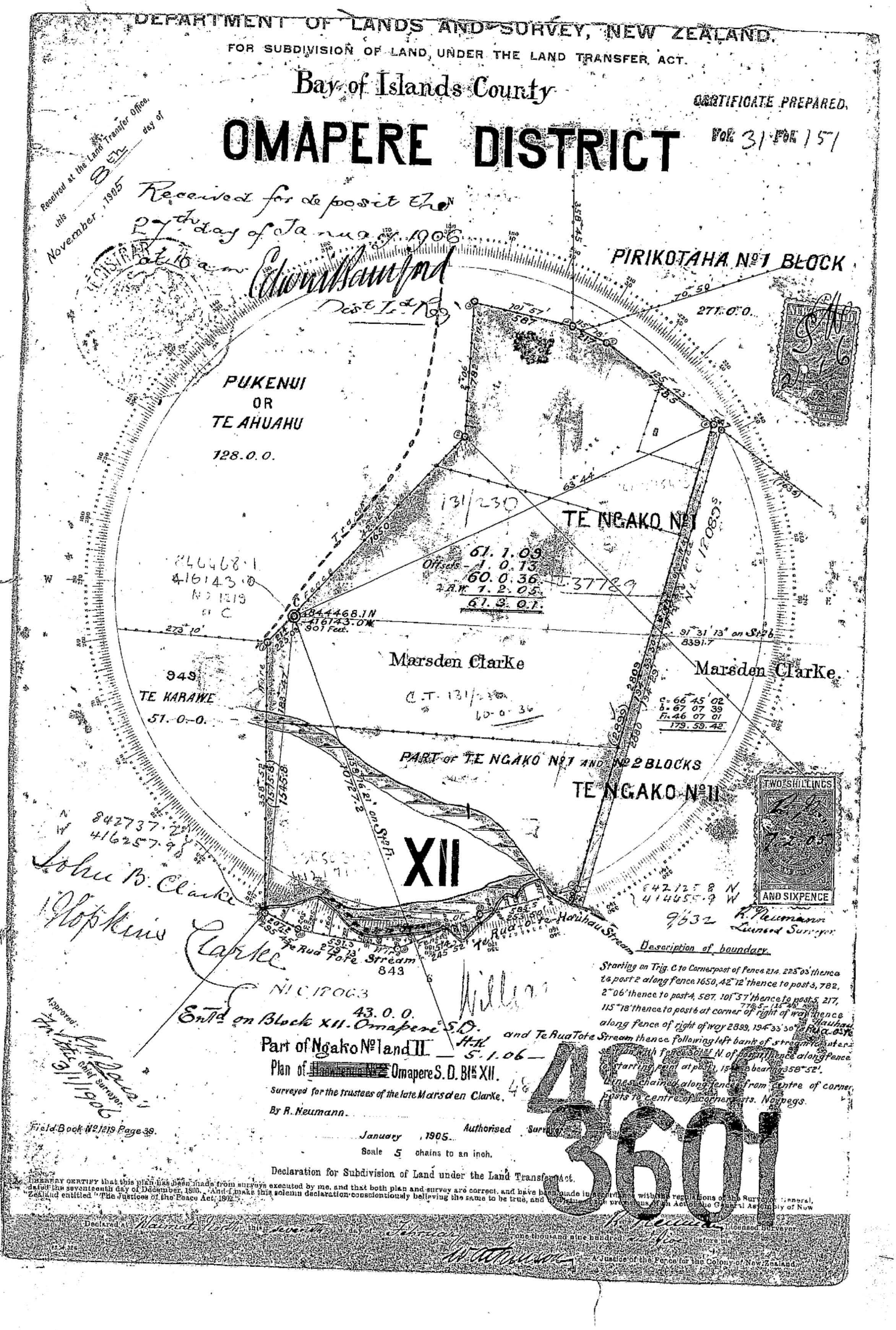
Figure 14: ML 951 (1878) showing the Maungakawakawa Block, and names on the stream.



Land Information New Zealand, Custom Software Limited, Date Scanned 2002, Last modified February 2002, Plan is probably current as at 29/05/2019

Figure 15: DP 3601 showing subdivision of the western side of Te Ngako Blocks I and II.

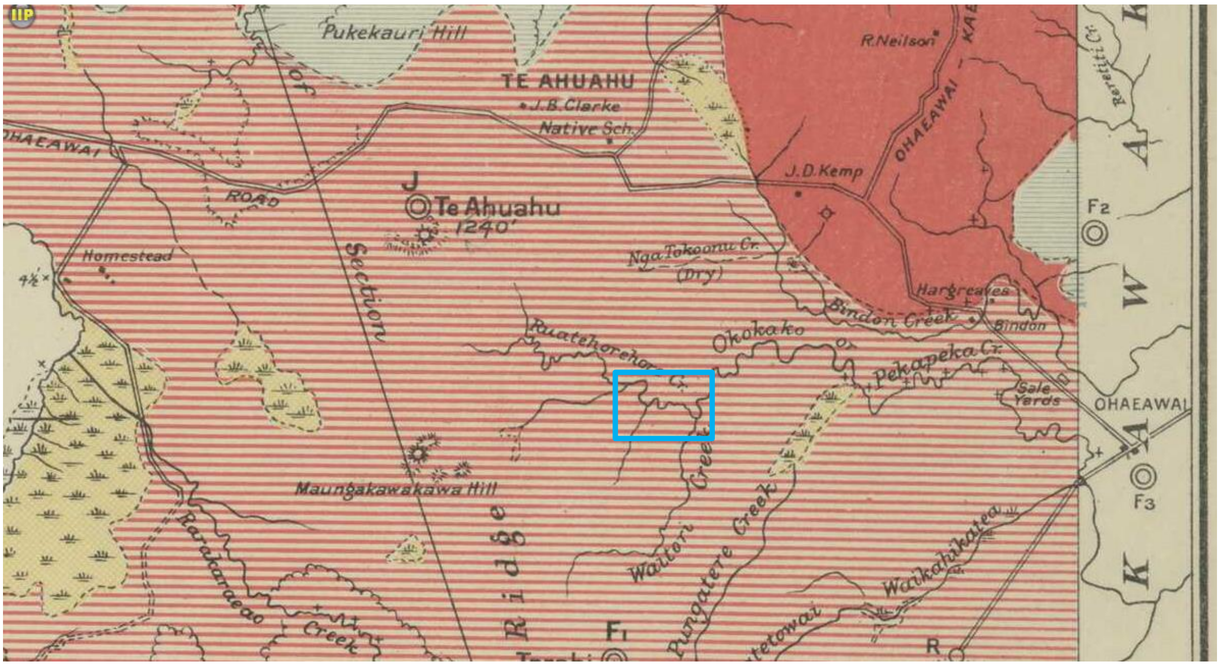


Figure 16: Detail from Crawford (1909).

Land Information New Zealand, Custom Software Limited, Date Scanned 2002, Last modified February 2002, Plan is probably current as at 29/05/2019

Figure 17: SO 20519 showing the southern part of the project area incorporated into the Remuera Special Settlement.

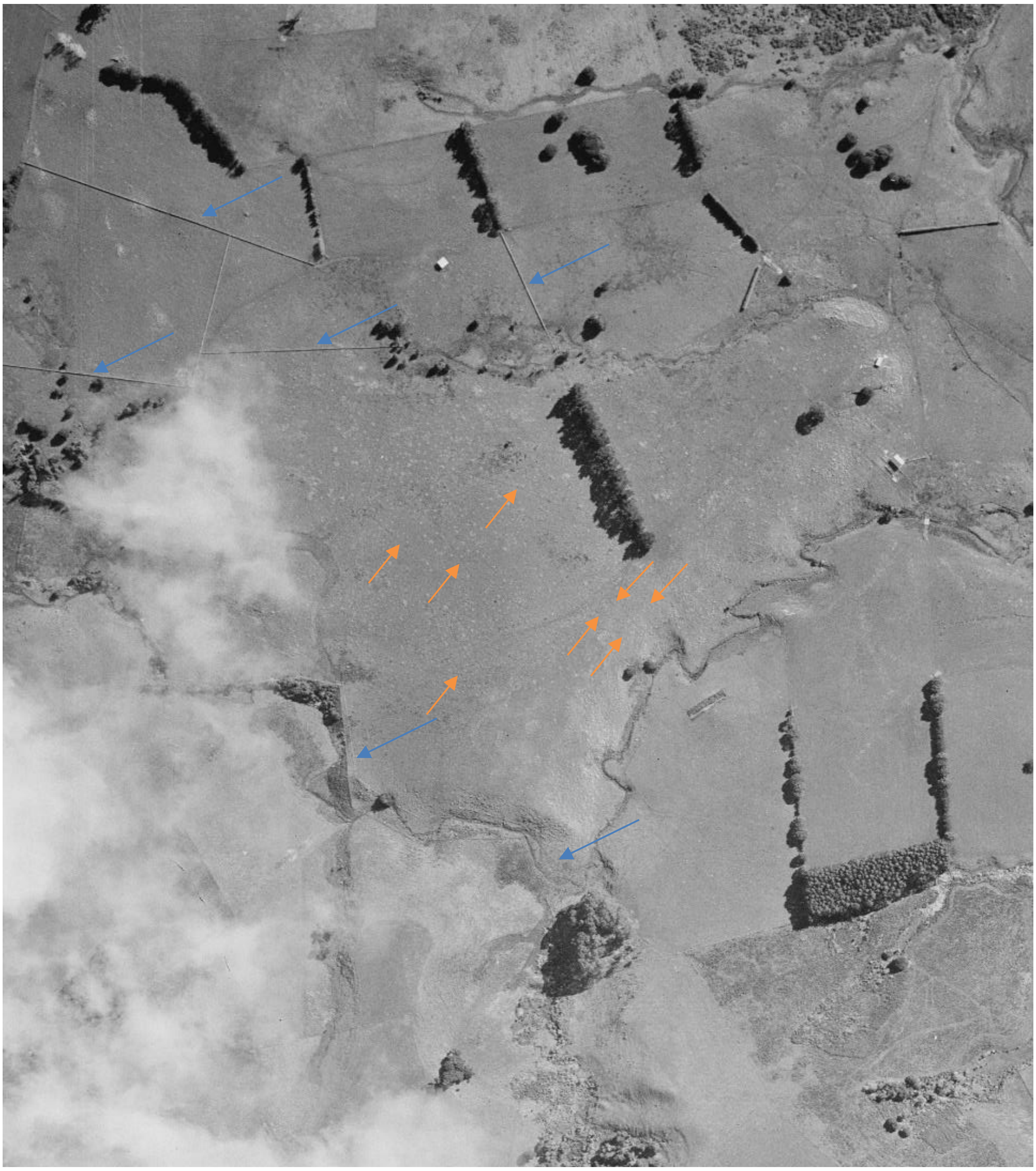


Figure 18: Detail from SN 209-548-47 (1955) with stone walls (arrowed blue) and drains (arrowed orange); small white circles may be horticultural mounds.

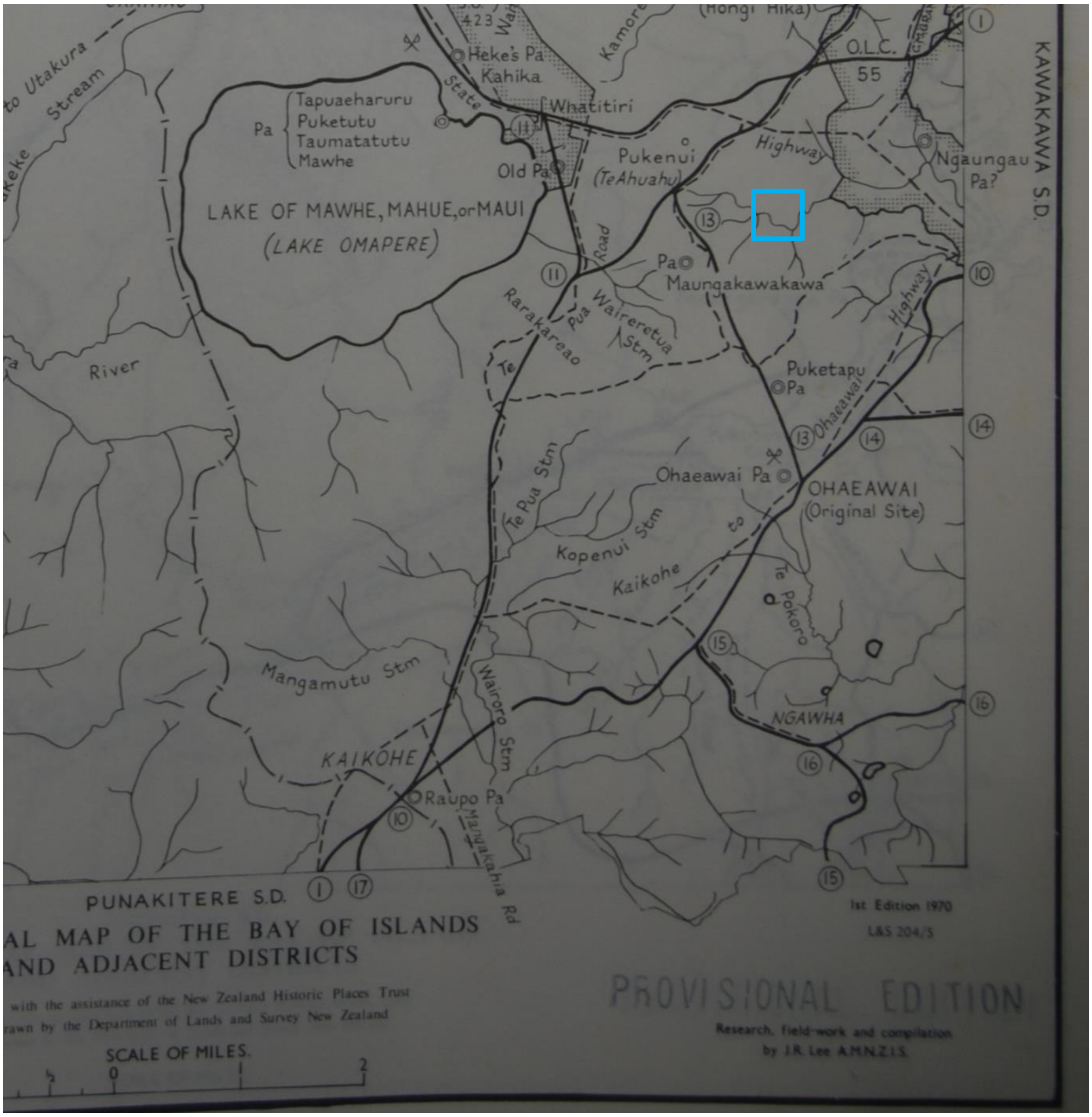


Figure 19: Historic places and tracks identified by Lee (1970).

6.0 Field Assessment

The Te Ruaotehauhau Water Storage Reservoir site was visited over the course of two visits, an initial high level walkover with the wider project team for approximately one hour on June 2020, and a day-long visit with a representative of the Tangata Whenua and the Water Trust community relations consultant in July 2020.

Survey conditions on both visits were fair to excellent, with most of the area is recently grazed pasture with good surface visibility, with smaller areas under regenerating native forest where the stream systems had been retired from grazing. The first visit accessed the project area via the eastern side belonging to the Dixon family, with the second visit via the western access over the Bell property.

Most of the project area has been inspected, apart from the north eastern side, on the Dixon property, which was stocked at the time. The southern valley has also not been inspected.

A number of archaeological sites and features or other features of historic or cultural interest were observed across the project areas and adjacent to the reservoir. These include dry stacked stone field boundary walls, low stone mounds associated with pre- or protohistoric Maori horticulture, possible pit or house floors, obsidian flakes, and taro.

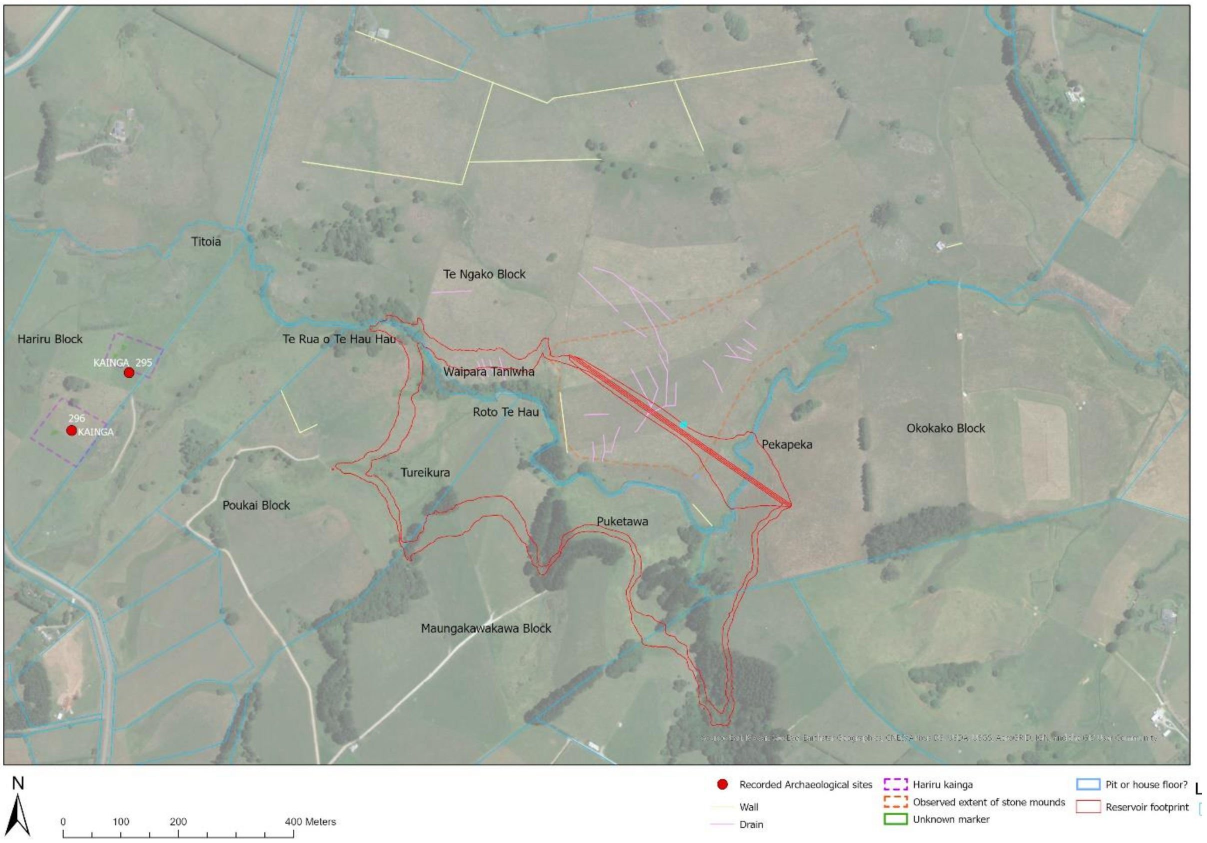


Figure 20: Archaeological, historic and cultural features at Te Ruaotehauhau reservoir.

6.1 Dry Stacked-stone Walls

In the course of the first visit, the presence of stacked dry-stone farm walls was noted on the Dixon property. These included intact/serviceable stone walls outside the project area on the Dixon property, and to the west on the Bell property, typically 1.6m high and 1.2m wide at the base. Two sections of largely destroyed stone wall, consisting of a single course of volcanic rock approximately 80cm wide and 40cm high were observed immediately east of the stream, on level to gently sloping ground, on the Dixon property. These features are within the inundation zone.

Maori horticultural systems are also known for having low, stacked dry-stone alignments or walls delineating plots or to encourage suitable microclimates, but the walls observed within the project area appear to be related to keeping stock out of the stream and ate to the historic or early modern period, after the land passed out of Maori ownership.

It is the overall extent, pattern and condition of the stone walls across a landscape and within in any geographic area which provides most of their heritage value, rather than any individual section of wall. The pattern of stone walls is not static and as working elements of historic farms the walls were continuously opened and closed throughout their history, and were replaced or were replaced by post and wire fences, according to the needs of the farmer and the changing organisation of the farm and fields. Therefore the position of gates/access ways through stone walls tend to change over time as farms developed, and the walls themselves are regularly repaired, removed and re-instated or replaced by cheaper alternatives such as post and wire fences.

The exception would be remnant of the earliest phase of stone wall building in the area from the mid-19th century, or potentially stone walls associated with important events or personalities in the history of the area. However there is no indication that these walls are particularly early, and they probably post-date the surveys and freeholding of the land.

6.2 Stone Gardening Mounds

Features consisted with pre- or proto-historic Maori horticultural activities were observed on the northern/eastern side of the stream, on the Dixon property. These features comprised stone and earth mounds. The mounds were observed on the flat to gently sloping ground approximately 5-10m above the stream.

The mounds are typically circular with diameters of 1.2-1.4m, spaced at intervals of 7-10m. The internal arrangement of several mounts was visible due to stock damage, the mounds comprising an outer ring of larger volcanic rocks with an inner core of smaller stones and soil. The area of observed stone gardening mounds covered an area of approximately 10ha.

No mounds were observed on the western side of the stream on the Bell property, and the features appear to be restricted to the lava flow from Te Ahuahu.

Furey provides the following account of stone mounds in her monograph Maori Gardening. An Archaeological Perspective (2006: 31):

> "In the archaeological literature, the terms 'stone heaps' and 'stone mounds' have been used interchangeably, but work focusing specifically on these features during the 1980s' investigations of the garden systems of South Auckland has indicated that there are differences between them (Coates 1992). Mounds have a distinctive rock and soil core covered with, or surrounded by, small rocks. Challis & Walton (1993) defined heaps at Pouerua as being structured piles using larger stones on the outside and smaller stones in the core. In contrast, mounds were defined as low piles with larger stones forming a perimeter and often containing a large quantity of earth. They suggested that heaps, which contain more stones, may represent the first attempt at stone clearance, and mounds may have been the result of a second level of clearance or may have functioned as gardens. A classification of mounds has been attempted based on plan, cross-section and composition (Rickard et al. 1983), but it is the internal composition that is important (Coates 1992), and this cannot always be ascertained from surface features. Mounds may also be fragmentary or dilapidated rows (Sullivan 1974)."

6.3 Shallow Trenches

A number of shallow, straight trenches or drains were observed at ground level during the site visit. Reference to aerial imagery suggests the area of stone mounds is criss-crossed by a reticulated network of such shallow trenches. Such features are commonly associated with Maori horticultural sites.

In between the site visits, a major storm even hit the northern part of the North Island causing widespread flooding; shortly after this even S. McManus observed these drains running, with water directed into the stream.

With regard to ditches and trenches, Furey states (2006: 38-40):

> "Ditches and trenches occur in various situations and probably had more than one function, according to local and regional conditions.
>
> …
>
> These ditch-and-trench features are often difficult to see and they may be severely under-represented in the records: because they are shallow (usually less than 500 mm deep) and narrow, they are vulnerable to erosion and infilling, and on flat land are destroyed by ploughing and intensive European land-use practices. Often they are only visible when seen from a distance in particular light conditions, and under close-cropped pasture grass.
>
> …
>
> Within this category, several different functions or overlapping functions are implied from the surface evidence. These include diversion of surface water away from gardens, and reticulation of water to flatter areas for specific crop requirements. This latter interpretation implies that taro (the only moisture tolerant cultigen) was grown on the flat, and kumara on the slopes; however, this may be a simplistic explanation. Examples of water diversion include systems with cross-ditches on the upper slope.
>
> …

> Although water or erosion control may be one reason for the presence of trenches on some sloping sites, in other places on gentle slopes or flat land, such as on sandy loam flats behind beaches or on volcanic soils, drainage was not an issue. At Pouerua, there are examples of slope trenches joining longer trenches in valley floors, and parallel trenches up to 300 m long that cross knolls and ridges in the lava flow (Fig. 10). Short, transverse trenches occur in the space between the long trenches (Phillips 1980). Given the free-draining nature of the volcanic soils at Pouerua, and the fact that these trenches cross over knolls, they are unlikely to have had a drainage or water-channelling function. Rather, they can be interpreted as garden boundaries, perhaps doubling as footpaths around the edges of gardens."

6.4 Possible Pits or House Floors and Mounds

Two possible pits or house floors were observed just off the level ground, on the bouldery tongue of land above the confluence of the main stream and the gully to the south. These features comprised approximately rectangular, stone-free areas.

To the west of the western extent of inundation, two large rock piles were observed around several totara. It appears as if field rock has been piled up in this area, and the totara is relatively young. However there appears to be an internal structure to the mounds, with large rocks around the outside and smaller stones in the centre. These may or may not be archaeological features but are outside the inundation area and will not be affected.

6.5 Artefacts

A large obsidian flake was recovered from the stream flats near the southern section of stone wall. The flake has a small amount of cortex on one side, suggesting primary reduction was occurring in the area. It is possible that the flake has washed down from further up the stream, but regardless of its ultimate origin on the stream it is suggestive of stone tool production nearby.

Figure 21: Maori horticultural system; looking north to Te Ahuahu over stone mounds.

Figure 22: Stock-trampled stone mounds after severe flooding.

Figure 23: Possible stone lined pit or house floor.

Figure 24: Southern stacked dry stone wall remnant.

Figure 25: Detail of stacked dry stone wall remnant.

Figure 26: Detail of stacked dry stone wall remnant.

Figure 27: Northern stacked dry stone wall remnant.

Figure 28: Obsidian flake from stream flats.

7.0 Significance Assessment

The following assessments find that P05/1091 is of moderate archaeological significance. It is a previously unrecorded, extensive proto- and possibly pre-historic Maori gardening system. Similar archaeological sites and features are known from the nearby Taiamai plains, Waitangi and Moerewa, where rocky volcanic soils predominate.

The system is largely intact, except for minor damage from stock, farm fencing and track making, and possibly from robbing rock for later historic/modern stone wall construction.

There have been few large scale investigations of such gardening systems, particularly in the last 20-30 years and there are still significant gaps in understanding their use. The careful investigation of such features is likely to have significant information potential.

There are extensive Maori Land Court records for the underlying blocks, Te Ahuahu, Okokako, Poukai, and Te Ngako, and the neighbouring Maungakawakawa and Hariru Blocks. These suggest intensive occupation of the area, and competition for resources in the late prehistoric and into the protohistoric period, associated with named ancestors and specific events.

Table 1: Significance assessment of P05/1091 Stone mounds/Pits/Terraces/Artefacts.

Significance Category	Value	Comment
Integrity, Condition and Information Potential	High	The observed features are in good condition although surrounding areas have been modified by fencing and other farming-related activity, and stock damage.
Diversity	High	The site comprises stone gardening or clearance mounds, stone walls, possible pits and mounds, and obsidian artefacts and taro. Associated subsurface features are likely to be present.
Rarity	Moderate	Similar features are recorded to the west around the western and southern side of Te Ahuahu, and they are well known from the adjacent Taiamai plains to the east. Other similar features may be present outside the observed area of the proposed reservoir.
Archaeological Context	Moderate	Three important maunga and pa overlook the site, Te Ahuahu, Maunga Kawakawa and Tarahi. The area was gardened and occupied into the mid-19th century and traversed by an important walking track in the same period linking Waimate with Oheawai.
Landscape Context and Amenity	Moderate	The features are visible and obvious at ground level but are not readily apparent from a distance or nearby Hariru Road or SH1.

Historical and Community Associations	Moderate	The features are not associated with any known person or event, but are likely to be of significance to Tangata Whenua. Several names are associated with the stream and its environs which may be significant, and the Hairiru kainga to the west are associated with Hare Matenga, a mid-late 19th century ancestor. The Te Ahuahu/Pukenui area is associated with the defeat of Ngati Pou and the expansion of Ngapuhi, and Kaitara an early 19th century ancestor. The area was the site of intensive occupation and feuding in the proto- and prehistoric period, and the battle between forces allied with Hone Heke, Kawiti and Waka Nene during the Northern War of 1845-46. There are extensive Maori Land Court records outlining whakapapa, ownership claims and land history for the area.

8.0 Assessment of Effects

The archaeological effects on P05/1091 from the proposed Te Ruaotehauhau reservoir are high.

Features recorded within the footprint of the dam wall, including stone mounds, drains, pits or house floors, and any associated subsurface features and artefacts will be destroyed, as will any features within borrow areas, haul roads, yards and hardstands. This amounts to approximately 7000m^2 of the observed 10ha of the horticultural system destroyed by the dam wall alone.

Features recorded within the inundation zone, which include the features noted above along with subsurface features, plus the remains of the dry stacked stone walls will be made unavailable for further research, and will be affected by compression from the water column, and potential bio-chemical effects of being submerged in water. This amounts to at least 3ha of the 10ha system.

Other features outside the inundation zone may be affected by fencing off the reservoir and e.g. the creation of new wetlands and areas of native plantings to offset those modified or destroyed by the reservoir.

It is possible that wooden artefacts may be found in waterlogged deposits on the valley floors and around the streams, as such artefacts were often cached in wetlands for protection, and a number of such finds are known from the Kaikohe-Omapere area (e.g. Slocombe 2002; Phillips et. al.: 2002) and from areas immediately adjacent to the project area (McManus to Carpenter pers. comm., 2020).

Subsurface features are unlikely to be proactively identified/identifiable prior to the commencement of earthworks, such as by exploratory or test excavation across the area by hand or mechanical excavator. Such features are more likely to be identified during top soil stripping through archaeological monitoring. Such monitoring should be targeted at those areas most likely to contain archaeological sites and features, namely ridge tops and gentle north-facing slopes and descending ridges and spurs.

Trenching for water supply pipes will need to be assessed as any earthworks in the distribution area has potential archaeological effects due to the high site density in the area.

Land use intensification as pastoral farming changes to horticulture in the identified distribution area for the reservoir is likely to have high archaeological effects as this area overlaps with an area of high archaeological site density which broadly maps to the extent of highly productive volcanic soils used by Maori in the pre- and proto Contact period for horticultural production with associated occupation areas nearby.

9.0 Findings and Recommendations

1) The Te Tai Tokerau Water Trust will need to apply for a general archaeological authority under the Heritage New Zealand Pouhere Taonga Act 2014 to modify recorded archaeological site P05/1091.

2) An archaeological management plan and research strategy will be required to manage archaeological effects from the project, and guide the investigation of archaeological features as mitigation for those effects, due to the scale of effects, significance of the site, and complexity of the project.

3) The applicant should undertake consultation with Tangata Whenua in light of the findings and recommendations from this report, as part of the archaeological authority process and should develop protocols around the appropriate tikanga for Maori archaeological sites and features and discuss opportunities for cultural monitoring of earthworks.

4) A detailed map of surface archaeological features should be prepared to inform the management plan and research strategy, prior to the preparation and submission of the archaeological authority application.

5) Proactive investigation of archaeological features within the footprint of the dam wall, and any other areas where earthworks are to be undertaken, will be required (borrow areas, haul roads, hard stands, and yards), guided by the research strategy.

6) A representative sample of features to be inundated but otherwise not affected, will need to be investigated.

7) Archaeological monitoring may be required in other areas.

8) Areas of stone mounds and associated horticultural features outside the reservoir footprint should be identified for possible permanent protection through heritage covenants.

10.0 Summary

Geometria Ltd was commissioned by Williamson Water & Land Advisory to undertake an archaeological assessment of the proposed new Te Ruaotehauhau Water Storage Reservoir near Ohaeawai, on behalf of the Te Tai Tokerau Water Trust.

The proposed new reservoir will affect an archaeological landscape, comprising approximately 10ha of proto and or pre-historic Maori horticultural features. Artefacts, cultivable taro, obsidian artefacts, and historic stone walls are found in association with the horticultural system which comprises low stone mounds and shallow trenches. These features were previously unrecorded, and have now been added to the New Zealand Archaeological Association database ArchSite as P05/1091.

While not locally or regionally rare, these features are in good condition and are associated with a highly significant historic and cultural landscape. The site has been assessed as being of moderate archaeological significance overall.

The Te Ruaotehauhau Water Reservoir will destroy approximately 7000m^2 of these features, with additional effects on 3ha due to modification by inundation within the reservoir footprint. There will likely be additional effects on subsurface archaeological features, and effects from haul roads, borrow areas, yards and hard stands, and the development of wetlands and areas in native planting to offset those affected by the reservoir. There are also likely to be downstream effects from developing pipe services to supply water from the reservoir, and land use change/intensification from horticultural development.

An archaeological authority from Heritage New Zealand under the Heritage New Zealand Pouhere Taonga Act 2014 will be required for the construction of the dam and reservoir itself. Such an authority, if granted, will likely contain a number of conditions for archaeological mitigation.

Given the scale and complexity of the project a comprehensive archaeological management plan and research strategy will be required to manage effects and guide investigation of the site.

Proactive investigation of features to be destroyed and a sample of features to be inundated will be required, prior to site establishment and bulk earthworks. Other works will require archaeological monitoring and investigation as necessary.

Such investigation will use standard archaeological methods but will also require radiocarbon and microfossil analysis. Such an investigation and associated analysis and reporting will exceed the $100,000 threshold which needs to be indicated in the archaeological authority application to Heritage New Zealand Pouhere Taonga.

11.0 References

11.1 Books and Reports

Best, S., n.d. Proposed Southern Landfill Site, Kaikohe: Scoping Report, Archaeological Overview.

Crawford, R., 1909. Geological Map of the Omapere Survey District. New Zealand Geological Survey. Wellington.

Furey, L., 2006. Maori Gardening. An Archaeological Perspective. Department of Conservation, Whangarei.

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Maingay, J., 2003. Archaeological Inspection of Pa Site N15/16, Ngawha.

Lee, J., 1983. 'I have named it the Bay of Islands…' Hodder and Staughton, Auckland.

Phillips, C., D. Johns and H. Allan, 2002. Why did Maori bury artefacts in the wetlands of pre-contact Aotearoa/New- Zealand?. Journal of Wetland Archaeology, Vo. 2, p. 39-60.

Robinson, J., 2008. Archaeological Monitoring at St Michael's Church and Ohaewai Gunfighter Pa, Ngawha.

Sissons, J., W. Wihongi, and P. Hohepa,1987. Nga Puriri o Taiamai. A political history of Nga Puhi in the inland Bay of Islands. The Polynesian Society, Auckland.

Slane, C. and J. Grant, 1980. Lake Omapere Survey Report.

Slocombe, A., 2002. An Archaeological Investigation of Wetland Site, P06/82, Kaikohe. Department of Conservation, Whangarei.

Walton, A., 1982. Ngawha Springs: An Archaeological Survey.

11.2 Maps, Plans, Photographs and Other Images

DP 3601.

DP 4440.

DP 11715.

DP 13915.

ML 453.

ML 525.

ML 860.

ML 861.

ML 876.

ML 877.

ML 879.

ML 947.

ML947A.

ML 948.

ML 949.

ML 950.

ML 951.

ML 1130.

ML 1366.

ML 1367.

ML 1918.

ML 2689.

ML 2690.

ML 5904.

ML 6042.

ML 7305.

ML 7870.

ML 7919.

ML 1925.

ML 8398.

ML 4800.

ML 8402.

ML 8474.

ML 9068.

ML 9069.

ML 9167.

ML 10249.

ML 10271.

ML 10539.

ML 11333.

ML 11411.

ML 11479.

ML 11489.

ML 11613.

ML 11705.

ML 11841.

ML 12063.

ML 12089.

ML 12185.

ML 12695.

ML 12707.

ML 12941.

ML 13327.

ML 13329.

ML 14479.

ML 14596.

ML 14705.

ML 14797.

ML 14596.

ML 14820.

ML 14886.

ML 15496.

ML 15505.

ML 15579.

ML 15677.

ML 15874.

ML 15908.

SO 808.

SO 20493..

SO 20495.

SO 20519.

SO 20579.

SO 23405.

SO 23407.

SO 24001.

SO 25697.

SO 29147.

SO 29375.

SO 30055.

SO 30547.

SO 33005.

SO 36637.

SO 41917.

SO 45974.

Appendix A – Archaeological Site Record

NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

ARCHSITE
archaeological site
recording scheme

Site Record Form

NZAA SITE NUMBER: P05/1091

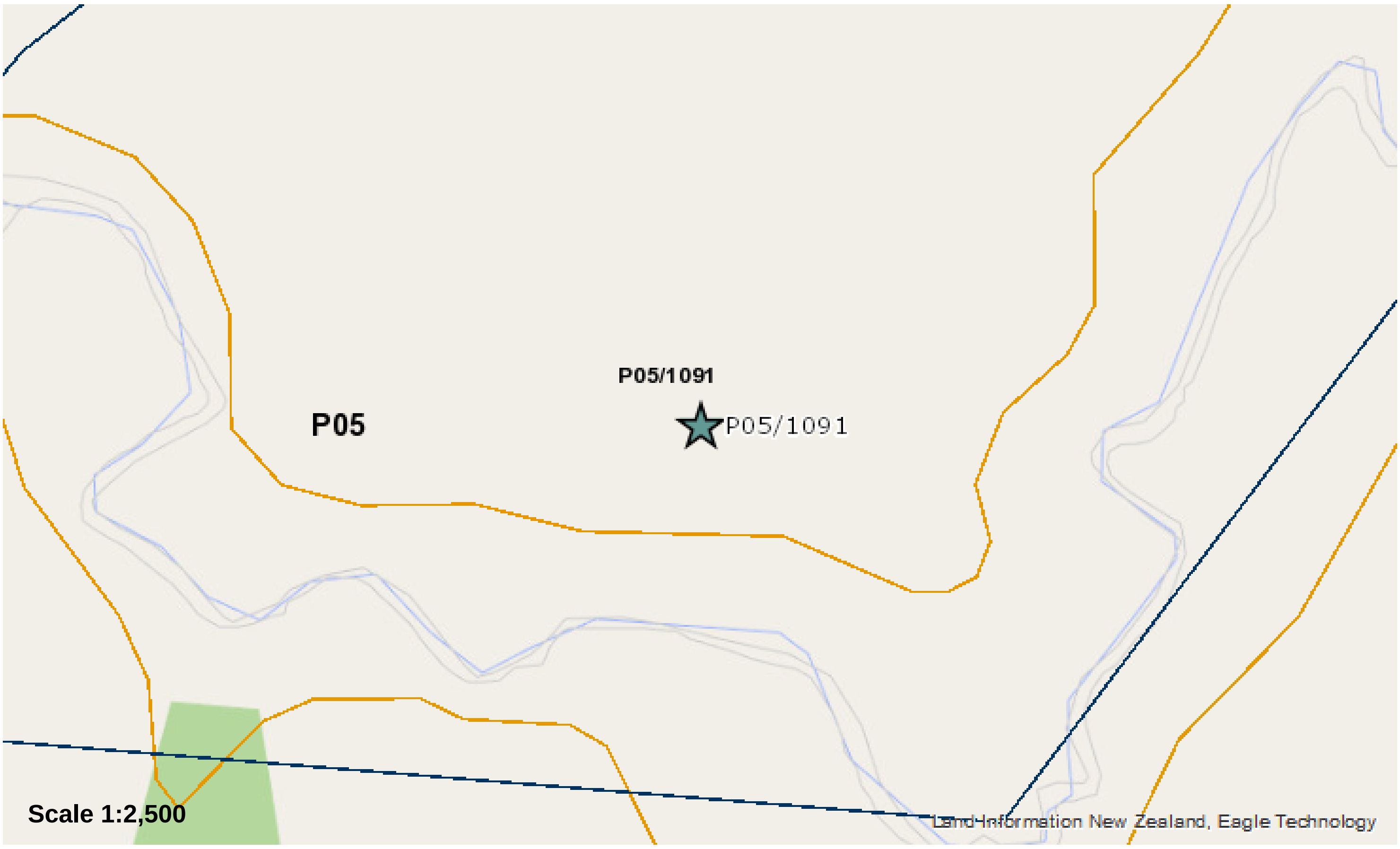
SITE TYPE: Maori horticulture

SITE NAME(s):

DATE RECORDED:

SITE COORDINATES (NZTM) Easting: 1677711 **Northing:** 6087839 **Source:** On Screen

IMPERIAL SITE NUMBER: **METRIC SITE NUMBER:** P05/1091



Finding aids to the location of the site

North side of Te Rua o Te Hau Hau (or Hou Hou) Stream, on Lot 2 DP 442506, one km east of Hairuru Road and 1.2km south of SH1. On level to gently rolling ground 5-10m above the stream.

Brief description

Horticultural features: stone and earth mounds, drains, artefact

Recorded features

Artefact - obsidian, Drain, Mound, Pit, Stone heap/ mound, Stone wall, Taro, Trench

Other sites associated with this site

SITE RECORD HISTORY	NZAA SITE NUMBER: P05/1091

Site description

Updated 11/08/2020 (Field visit), submitted by jonocarpenter , visited 10/06/2020 by Carpenter, Jonathan
Grid reference (E1677711 / N6087839)

Features consisted with pre-/proto-Contact Maori horticultural activities were observed on the northern/eastern side of the stream, on the Dixon property (Lot 2 DP 442506) in the course of an assessment for a proposed reservoir.

These features comprised stone and earth mounds. The mounds were observed on the flat to gently sloping ground approximately 5-10m above the stream. The mounds are typically circular with diameters of 1.2-1.4m, spaced at intervals of 7-10m. The internal arrangement of several mounts was visible due to stock damage, the mounds comprising an outer ring of larger volcanic rocks with an inner core of smaller stones and soil.
The area of observed stone gardening mounds covered an area of approximately 10ha. This area is associated with the lava flow from Te Ahu Ahu to the north.

A number of shallow, straight trenches were observed at ground level during the site visit. Reference to aerial imagery suggests the area of stone mounds is criss-crossed by a reticulated network of shallow trenches. Such features are commonly associated with Maori horticultural sites.

In between the site visits in early June and late July, a major storm even hit the northern part of the North Island causing widespread flooding; shortly after this event neighbouring land owner S. McManus observed these drains running, with water directed into the stream.

Two possible pits or house floors were observed just off the level ground, on a bouldery tongue of land above the confluence of the main Rua o Te Hau Hau stream and a stream and gully to the south. These features comprised approximately 4x2x.5m deep rectangular, stone-free areas in the otherwise boulder area.

A large obsidian flake was found on the small flat beside the stream, below this tongue of land.

Two sections of largely destroyed stacked dry stone wall, consisting of a single course of volcanic rock approximately 80cm wide and 40cm high were observed immediately east of the stream and north of the stream, on level to gently sloping ground, on the Dixon property. Intact/serviceable stone walls outside the project area to the east on the Dixon property, and to the west on the Bell property on the other side of the stream (Section 12S and 16S Remuera Settlement). These walls appear to be from the late historic or early modern period and consistent with European pastoral farming.

Two possible large stone mounds were observed on the west side of the stream but require further investigation. They comprise two mounds approximately 5-10m wide, with large outer rocks and a core of smaller rocks, separated by a metre of clear ground. Young totara are growing on the mounts. The mounds are in an area of intermittent rock outcrops associated with the lava flow from Maungakawakawa to the west. Several hundred metres to the west are the Hariru kainga recorded on the 1868 survey plan of the same name, which have rock mound burials associated with them. If not for the smaller rocks in the core of the feature, I would have considered them to be farm clearance mounds.

These features are within or on the edges of the proposed MN06 Reservoir project sponsored by the Te Tai Tokerau Water Trust. See:

Carpenter, J., 2020. Archaeological Assessment of the Proposed MN06 Water Storage Reservoir. Ohaeawai. Unpublished report for Williamson Water and Land Advisory and the Te Tai Tokerau Water Trust.

Condition of the site

Statement of condition

Updated: 12/08/2020 - Good – Majority of visible features are intact, but some minor loss of definition and/or damage

Current land use:

Updated: 12/08/2020 - Grazing

Threats:

Updated: 12/08/2020 - Stock trampling, Farming practices, Erosion, Services/ utilities

NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

SITE RECORD INVENTORY	**NZAA SITE NUMBER:** P05/1091

Supporting documentation held in ArchSite

Appendix I. Contaminated Land Review

Williamson Water & Land Advisory
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Te Tai Tokerau Water Trust
Whangarei

Attention: Andrew Carvell

14 September 2020 WWLA0239

Te Ruaotehauhau Water Storage Reservoir, Kaikohe – Ground Contamination Review

Williamson Water & Land Advisory (WWLA) has prepared this letter to support resource consent applications for a new water storage reservoir between Hariru and Remuera Settlement Roads, Kaikohe, referred to as site Te Ruaotehauhau Water Storage Reservoir.

1. Introduction

WWLA is assisting Te Tai Tokerau Water Trust with consenting of the Te Ruaotehauhau Water Storage Reservoir, one of four proposed reservoirs in the Mid-North Scheme: Matawii (MN10), MN16, and MN02. Te Ruaotehauhau Water Storage Reservoir was identified as a viable water storage option through the Northland Water Storage and Use Project (NWSUP), as a complementary part of a distributed community scheme. The four storage sites will be connected through a distribution system, with the Te Ruaotehauhau Water Storage Reservoir capable of delivering water to supply approximately 360 hectares of horticultural land.

This letter documents the work undertaken to inform the consenting process in terms of the National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health (2011) Regulation (NESCS). In summary, this letter confirms that the NESCS does not apply to the Te Ruaotehauhau Water Storage Reservoir footprint as no potentially contaminating activities were identified within the footprint.

2. Scope of Work

The Te Ruaotehauhau Water Storage Reservoir ground contamination review was undertaken to determine whether land use activities with potential to cause ground contamination had occurred within the reservoir and dam embankment footprint. The following scope of works was undertaken:

- Review of available historical information including:
  - Historical aerial photographs from 1959 to 2019, readily available on Google Earth and Retrolens; and
  - Interviews with the landowner.
- Assessment of available geological information in the project database including from geotechnical, archaeological and ecological studies;
- Assessment of identified land use activities against the Hazardous Activity and Industries List (HAIL)[1]; and
- Site walkover by a WWLA contaminated land specialist.

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[1] Ministry for the Environment Hazardous Activity and Industries List

Intrusive investigations were not part of this report.

This documentation is prepared in general accordance with CLMG 1[2] and industry best practice guidance whose use is directed by CLMG 2[3] in terms of assessing potential for contamination at the site and applicability of the NESCS.

3. Site Description and Setting

The footprint is located on properties along Hariru and Remuera Settlement Roads, Kaikohe, as described by **Table 1**. The proposed reservoir boundaries are shown in **Figure 1**. The bulk of the footprint is at approximately 200 m RL. Geologically, the site lies within Kerkeri Group basalts. Watercourses in the area drain to the Kerikeri inlet.

Table 1: Property details

Legal Description	Record of Title	Estate Type	Registered Owner
Lot 2 Deposited Plan 442506	552150	Fee Simple	D.G. Dixon & Son Limited
Lot 5 Deposited Plan 533953	878815	Fee Simple	Bruce Campbell Bell Helen Sheila Bell
Section 16S Remuera Settlement	NA1034/210	Fee Simple	Bruce Campbell Bell Helen Sheila Bell
Lot 3 Deposited Plan 97908	NA53B/976	Fee Simple	Mountain View Farms 2018 Limited
Okokako	NA768/20	Fee Simple	D.G. Dixon & Son Limited

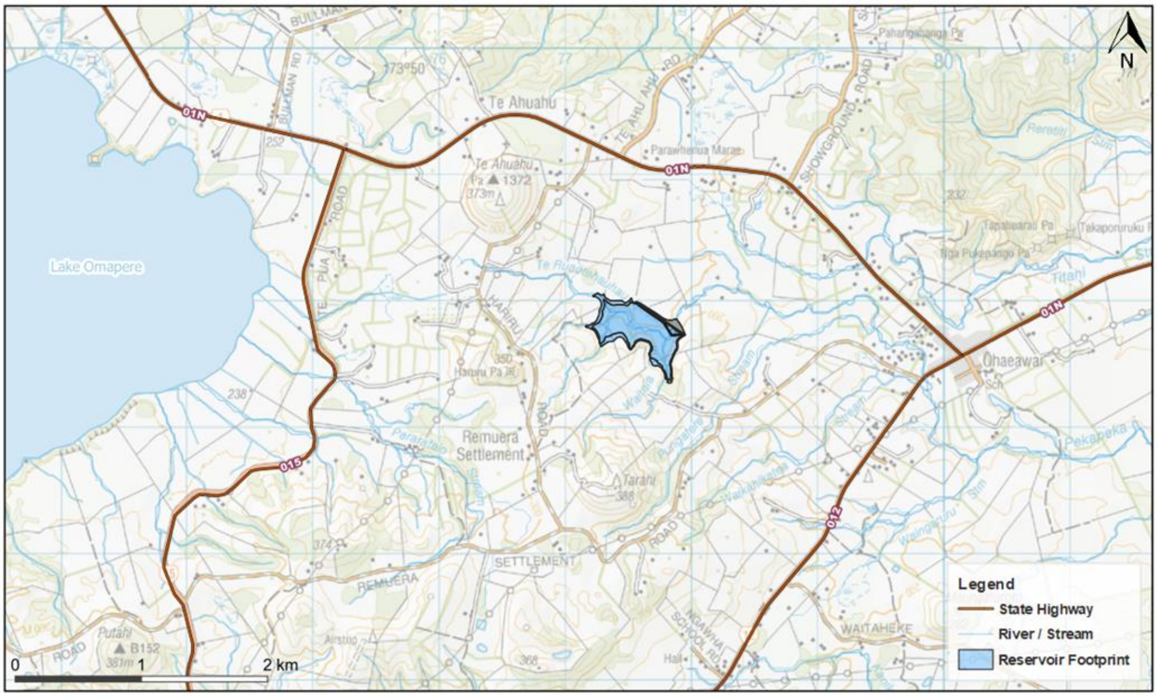

Figure 1: Location of Te Ruaotehauhau Water Storage Reservoir

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[2] Ministry for the Environment, 2011: Contaminated Land Management Guideline (CLMG) No.1 – Reporting on Contaminated Sites in New Zealand.
[3] Ministry for the Environment, 2011: Contaminated Land Management Guideline No.2 – Hierarchy and Application of Guideline Values in New Zealand.

4. Land Use and History

The reservoir footprint is currently pastoral farmland and based on review of historical aerial imagery has been pasture since at least the 1950s. Aside from construction of fencing, access tracks, and rotational feed-cropping during the 2000s, no other activities were evident on the imagery. The aerial imagery review is provided as **Table A1**, **Attached**.

The site walkover confirmed the most recent aerial imagery review (Google Earth, 2020) with fencing present and no roadways or other structures identified. Use of herbicides was observed (strips of dead vegetation) along fence lines.

Photograph 1. Current features within the Te Ruaotehauhau Water Storage Reservoir footprint.

5. Potential for Contamination

The historical review confirms only a pastoral use within the proposed reservoir footprint, and within land immediately surrounding the footprint. We do not consider rotational stock feed cropping to be a HAIL activity in this context, given it has occurred post the period when persistent pesticides were used (pre-1980s) and due to its short duration. Use of herbicides are in this case not considered a HAIL as modern herbicides have a very short residual time in soils (<2 weeks).

Therefore, no contaminated land-related land uses included on the HAIL have been identified within the proposed reservoir footprint.

6. NESCS Applicability

The NESCS came into effect on 1 January 2012. The legislation sets out nationally consistent planning controls appropriate to district and city councils for assessing potential human health effects related to contaminants in soil. The regulation applies to specific activities (including land use change and soil disturbance, activities associated with reservoir development) on land where an activity included on the HAIL has occurred.

Our assessment of the NESCS applicability is set out in **Table 2**. The checklist review confirms the NESCS does not apply to the reservoir development works as it does not meet the applicability for *Land Covered* (Regulation 5, Clause 7).

Table 2. NESCS applicability checklist

NESCS Requirement	**Applicable to site**
Is an activity described on the HAIL currently being undertaken on the piece of land to which this application applies?	No
Has an activity described on the HAIL ever been undertaken on the piece of land to which this application applies?	No
Is it more likely than not that an activity described on HAIL is being or has been undertaken on the piece of land to which this application applies?	No
If 'Yes' to any of the above, then the NES Soil may apply. The five activities to which the NES applies are:	
Is the activity you propose to undertake removing or replacing a fuel storage system or parts of it?	No
Is the activity you propose to undertake sampling soil?	No
Is the activity you propose to undertake disturbing soil?	Yes
Is the activity you propose to undertake subdividing land?	Potentially
Is the activity you propose to undertake changing the use of the land?	Yes
CONCLUSION: The NESCS does not apply to the Te Ruaotehauhau Water Storage Reservoir development.	

7. Conclusions

A desk-study and site walkover review within the proposed Te Ruaotehauhau Water Storage Reservoir footprint shows the site has been pastoral farmland over most of its history, with no current or previously occurring HAIL activities present.

There are also no HAIL activities identified immediately outside the current reservoir footprint, thus any modifications to the reservoir footprint will not trigger additional considerations from a contaminated land perspective.

No contaminated land related mitigation or management is required for consenting or construction based on the information available at this time.

Please do not hesitate to contact the undersigned should you require any further clarification.

Yours sincerely,

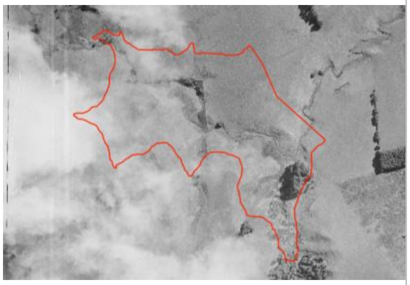
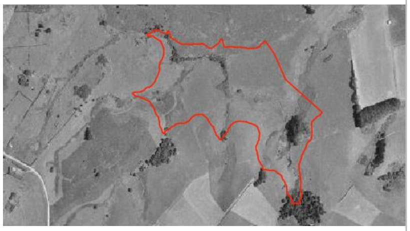
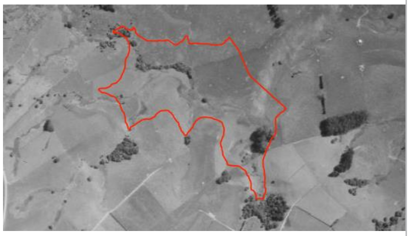
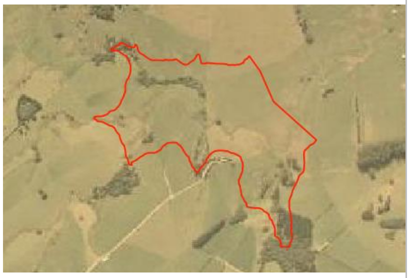
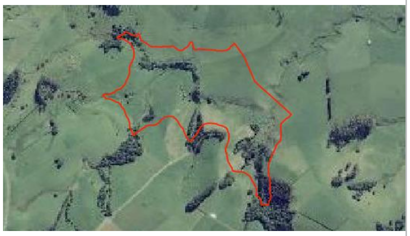
MWilliamson

Wendi Williamson
Principal Contaminated Land Advisor
+64 21 613 408 | wendi.williamson@wwla.kiwi

Attached:

Table A1. Historical aerial imagery review

Table A1. Historical aerial photograph review.

Photograph date (source)	Activities	Aerial image
1955 Retrolens	The footprint is partially obscured by cloud in the western side. The land appears undeveloped bare pastoral. A watercourse runs from the northwest to the southest corner and is vegetated in patches with shrubs and large trees in the west. Potential slope instability visible in the central east of the site directly north of the large trees.	
1969 Retrolens	No significant changes are apparent. The western portion of the site is now visible, with evidence of basic road tracks loosely following watercourse channel contours.	
1981 Retrolens	Basic roading appears to no longer be visible. Watercourse channels are mostly dry and unvegetated, with vegetation unchanged since the 1955 imagery. Fences can be seen in the northwest.	
2000 Far North District Council Geomaps	Roading has been extended approaching the centre of the footprint. No changes are apparent within the footprint.	
2006 Far North District Council Geomaps	Vegetation appears to have intensified along watercourse channels.	
2009 Google Earth	New roading tracks can be seen leading into the northwest corner. Extensive planting or irrigating has been undertaken in the central segment of the site. A narrow road is present through the segment.	

Photograph date (source)	**Activities**	**Aerial image**
2013 Google Earth	No significant changes are apparent. Roading has not progressed into the site, and several tracks appear to no longer be in use.	
2019 Google Earth	Very little has changed in the area between 2013 and the most recent aerial images. Slope instability	

Appendix J. Proposed Conditions of Resource Consent

Te Ruaotehauhau Water Storage Reservoir: Proposed Resource Consent Conditions

Glossary of Abbreviations and Definitions

AMP	Avifuana Management Plan
CMP	Construction Management Plan
BMP	Bat Management Plan
ESCP	Erosion and Sediment Control Plan
FFSRP	Freshwater Fauna Salvage and Relocation Plan
FNDC	Far North District Council
LMP	Lizard Management Plan
NRC	Northland Regional Council
ORMP	Operational Reservoir Management Plan
WCR	Works Completion Report
WSMP	Water Supply Management Plan

Authorised Activities

To undertake the following activities associated with the construction and operation of the Te Te Ruaotehauhau Water Storage Reservoir at or about location co-ordinates: <To be inserted>

1. Erect (construct) and use a water storage dam in, on, and over the bed of Te Ruaotehauhau Stream, including depositing a substance in, on, or under the beds.

2. Disturb the bed of Te Ruaotehauhau Stream, including any excavation, drilling and tunnelling.

3. Reclaim the bed of Te Ruaotehauhau Stream associated with constructing the reservoir embankment.

4. Dam and divert water in the Te Ruaotehauhau Stream and Waitaia Stream.

5. Earthworks associated with the construction of a dam.

6. Vegetation clearance associated with the construction of a dam and land-contouring.

7. Divert and discharge stormwater associated with earthworks for the construction the dam and land contouring.

8. Take and use water from Te Ruaotehauhau Stream Water Storage Reservoir.

9. Discharge stormwater to water and to land where it may enter water during land disturbance activities.

General Conditions

1. The Consent Holder must undertake the activities in general accordance with Te Ruaotehauhau Water Storage Reservoir application for resource consents. If there is any inconsistency between these conditions and the application for resource consents, the conditions take precedence.

2. The Consent Holder must, on becoming aware of any discharge associated with the Consent Holder’s operations that is not authorised by these consents:

   a. Immediately take such action, or execute such work as may be necessary, to stop and/or contain the discharge; and

   b. Immediately notify Northland Regional Council (NRC) by telephone of the discharge; and

   c. Take all reasonable steps to remedy or mitigate any adverse effects on the environment resulting from the discharge; and

d. Report to the NRC’s Compliance Manager in writing within one week on the cause of the discharge and the steps taken, or being taken, to effectively control or prevent the discharge.

Construction

3. Prior to the commencement of construction works pursuant to these consents, the Consent Holder must provide NRC and Far North District Council (FNDC) with a Construction Management Plan (CMP) prepared by a suitably qualified and experienced person(s). The CMP must be approved by NRC and FNDC prior to the commencement of construction activities.

4. The CMP must include (where relevant):

    a. The name and contact details of the principal contractor and sub-contractors.

    b. The name and contact details of the person(s) responsible for implementing and monitoring the CEMP;

    c. Detailed design drawings;

    d. The construction methodology and timetable;

    e. Diagrams and/or plans, of a scale suitable for on-site reference, showing the locations of the cut and fill operations, disposal sites for unsuitable materials and erosion and silt control structures/measures;

    f. An Erosion and Sediment Control Plan (ESCP) to be prepared in accordance with Condition 5 of this resource consent;

    g. Design details of the stream diversion works, including culvert, required for the diversion of water past or through the dam construction site;

    h. Measures to prevent spillage of fuel, oil and similar contaminants;

    i. Contingency containment and clean-up provisions in the event of accidental spillage of hazardous substances;

    j. Measures to ensure sediment or dust discharge from the earthworks activity does not create a nuisance on neighbouring properties;

    k. Means of ensuring contractor compliance with the CEMP;

5. The ESCP required as part of the CMP must contain:

   a. The expected duration (timing and staging) of earthworks, disposal sites for unsuitable materials, and clean water diversions;

   b. Diagrams and/or plans, of a scale suitable for on-site reference, showing the locations of the cut and fill operations, disposal sites for unsuitable materials and erosion and silt control structures/measures;

   c. Details of all erosion and sediment controls;

   d. Supporting calculations and catchment boundaries for the erosion and sediment controls;

   e. The commencement and completion dates for the implementation of the proposed erosion and sediment controls; and

   f. Details of surface revegetation of disturbed sites and other surface covering measures to minimise erosion and sediment runoff following construction.

6. NRC and FNDC must be notified of commencement of works at least two weeks beforehand. A site meeting between the principal contractor and the Council's assigned monitoring officers must be held on site prior to any earthworks commencing.

7. Copies of the consent documentation must be provided to any person who is to carry out the works authorised by these consents, prior to any work commencing.

8. All earthworks must be undertaken in accordance with the certified CMP or any amendments, as agreed in consultation with the Northland Regional Council's assigned monitoring officer.

9. All bare areas of land beyond the reservoir footprint must be stabilised following the completion of earthworks.

10. No earthworks must be carried out between 1 May and 30 September in any year unless the prior written agreement of the council's Compliance Manager has been obtained.

11. Any request to undertake works between 1 May and 30 September in any year must be in writing and must be made at least two weeks prior to the proposed date that the works are required to be undertake. This written request must include an amended CEMP for the works that has been prepared in accordance with Condition 3.

12. Works in any active river channel[1] must be planned to minimise the duration of the works and the generation of sediment.

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[1] Active river channel is the part of the river bed where water is flowing but does not include parts of the bed where water has been diverted to enable works to be undertaken.

13. Drains and cut-offs constructed to divert stormwater must be capable of conveying stormwater during not less than the estimated 1 in 20-year rainfall event. All channels on grades greater than 2% must be protected to avoid erosion occurring.

14. No slash, soil, debris and detritus associated with the exercise of these consents must be placed in a position where it may be washed into any water body.

15. All bare areas of land that will not be covered by water must be covered with aggregate or topsoiled and established with a suitable vegetation to achieve an 80% groundcover within six months of the completion of earthworks. Temporary mulching or other suitable groundcover material must be applied to achieve total groundcover of any areas unable to achieve the above requirement.

16. The construction operations must not give rise to any discharge of contaminants (e.g. dust), at or beyond the property boundary, which is noxious, dangerous, offensive or objectionable to such an extent that it has, or is likely to have, an adverse effect on the environment. Dust control measures must be available on site, to ensure compliance with this condition.

17. The discharges from the land disturbance activities must not cause any of the following effects on the water quality of Te Ruaotehauhau Stream, as measured 200 metres from the dam footprint, compared to sites within the water body, unaffected by land disturbance activities:

    a. The production of any conspicuous oil or grease films, scums or foams, floatable or suspended materials, or emissions of objectionable odour; or

    b. Any conspicuous change of colour or visual clarity.

18. The upstream and downstream passage of longfin and shortfin eels must be provided for and be effective under the flow range conditions of the Te Ruaotehauhau Stream environment during the construction of the dam and reservoir area.

19. All construction activity under this consent must comply with the certified Freshwater Fauna Salvage and Relocation Plan (FFSRP), Bat Management Plan (BMP), Avifauna Management Plan (AMP), and Lizard Management Plan (LMP).

20. A Works Completion Report (WCR) must be prepared within 3 months of completion of earthworks. The report must be submitted to NRC and FNDC for certification. The WCR must contain sufficient detail to address the following matters:

    (a) A summary of the works undertaken within the development area.

    (b) Records of unexpected contamination encountered and the response actions, if applicable.

General Water Take Conditions

21. A screening fish device must be maintained on the intake structure that limit the intake velocity across the screen to less than 0.3 metres/second and have no holes or slots with a diameter or width greater than 5 millimetres.

22. Prior to the first exercise of this consent, a water meter must be installed to measure the volumes of water taken, in cubic metres, for the take. The water meter must:

    (a) Be able to provide data in a form suitable for electronic storage;

    (b) Be sealed and as tamper-proof as practicable;

    (c) Be installed at the location from which the water is taken; and

    (d) Have an accuracy of +/-5%.

    The Consent Holder must, at all times, provide safe and easy access to each meter installed for Council to undertake visual inspections and record water take measurements.

23. The Consent Holder must verify that the meter required by Condition 22 is accurate. This verification must be undertaken prior to 30 June:

    (a) Following the first taking of water in accordance with this consent; and

    (b) At least once in every five years thereafter.

    Each verification must be undertaken by a person, who in the opinion of the Council's Compliance Manager, is suitably qualified. Written verification of the accuracy must be provided to the Northland Regional Council's assigned Monitoring Officer no later than 31 July following the date of each verification.

24. The Consent Holder must keep a record of the volume of water taken from each site of abstraction in cubic metres, including all nil abstractions, using the readings from the meter required by Condition 22. Recorded measurements must be kept in 15-minute increments.

25. The water meter must have an electronic datalogger for automatic logging of meter data.

26. A copy of the records required to be kept by Condition 24 must be forwarded to the Northland Regional Council's assigned Monitoring Officer daily via telemetry. In addition, a copy of these records must be forwarded immediately to the Council's assigned Monitoring Officer on written request. The records must be in an electronic format that has been agreed to by the council.

Advice Note: *If no water is taken during any calendar month then the Consent Holder is still required to notify the Northland Regional Council's Monitoring Manager in writing of the nil abstraction. Water use record sheets in an electronic format are available from the council's website at www.nrc.govt.nz/wur.*

Operation of the Te Ruaotehauhau Water Storage Reservoir (Compliance Performance Monitoring by NRC and FNDC)

27. The structures covered by these consents must be maintained in good order and repair so that they work effectively at all times.

28. The Consent Holder must, prior to the filling of the reservoir, prepare and submit an ORMP which sets out the methodologies, practices and procedures to be adopted in order to manage the reservoir. The ORMP must be submitted to NRC's Monitoring Manager for certification prior to operating the reservoir, and must contain the following details:

    (a) An overview of the reservoir characteristics, construction and features and where details about the construction can be found;

    (b) As-built drawings;

    (c) Roles and responsibilities of the various parties associated with the operation of the Matawii Water Storage Reservoir;

    (d) Inspection forms for engineering, water monitoring and maintenance inspections;

    (e) Design levels, flows, triggers and telemetric monitoring requirements;

    (f) Data management and information ownership;

    (g) Maintenance functions and reporting requirements;

    (h) Emergency Action and Response Plan; and

    (i) Details of annual reporting requirements to Northland Regional Council and Far North District Council.

29. Upstream and downstream passage for native eels must be provided during the operation of Te Ruaotehauhau Water Storage Reservoir. The methods for provision of native eel upstream and downstream passage during the operation of Te Ruaotehauhau Stream Water Storage Reservoir will be documented in the ORMP.

30. The ORMP will be reviewed following two full years of reservoir operation for the purpose of verifying the performance of the plan, in particular in meeting residual flow requirements. The review, including any proposed changes to improve the performance associated with meeting

residual flow and fish passage requirements, will be submitted to the NRC before the end of the third year of reservoir operation.

31. The Consent Holder must submit to the FNDC by 30 September of each year a report from a suitably qualified and experienced independent registered engineer on the performance and maintenance of the dam structure and ancillary equipment. All recommended remedial works outlined in an annual report must be carried out promptly.

32. In addition to the annual reports required by Condition 31, a review of the safety and efficiency of the dam structure and ancillary equipment must be undertaken at five yearly intervals by a suitably qualified and experienced independent registered engineer. The review report must be for the preceding five-year period ending 30 June. A copy of the review report must be forwarded to the FNDC by the following 30 September. Any recommended remedial works must be carried out in accordance with the timeframe specified in the review report.

33. The maximum rate of the take from Te Ruaotehauhau Water Storage Reservoir must not exceed 190 litres per second.

34. Except during the initial filling of the dam post-construction, between 1 September and 30 April each year the exercise of these consents must not result in the flow of the unnamed tributary of Te Ruaotehauhau Stream, as measured immediately downstream of the dam, to be reduced below 29 litres per second.

35. Between 1 May and 31 August each year when catchment inflows (i.e., upstream of the dam) are less than 32 litres per second, the exercise of these consents must not result in the flow of the unnamed tributary of Te Ruaotehauhau Stream, as measured immediately downstream of the dam, to be reduced below 5.9 litres per second.

36. Catchment inflows into Te Ruaotehauhau Water Storage Reservoir must be based on a water balance approach, augmented where practical by direct flow measurements in representative sub-catchments, and as documented through the Operational Reservoir Management Plan (ORMP).

Advice Note: *If the building consent issued for the reservoir under the Building Act 2004 has a same or similar condition to Conditions of 31 and 32 of this resource consent, then Conditions 31 and 32 do not apply.*

Ecological Management

37. The Consent Holder must engage a suitably qualified expert(s) to develop the following management plans:

(a) A Freshwater Fauna Salvage and Relocation Plan (FFSRP) for all parts of the site where works will occur in-stream or aquatic habitat will be inundated will be developed.

(b) Avifauna Management Plan (AMP).

(c) Bat Management Plan (BMP)

(d) Lizard Management Plan (LMP.

These plans are intended to provide the methodologies that will be used to identify the presence of indigenous flora and fauna within each proposed area of works, and the methodology for the protection or removal. The plans must be prepared by a suitably qualified and experienced ecologist and the methodologies must be in accordance with nationally recognized and accepted methods.

38. The FFSRP must be submitted to NRC's Monitoring Manager for certification.

39. The BMP, AMP, and LMP must be submitted to the FNDC's Monitoring Manager for certification.

40. Additionally, the Consent Holder must, at least one month before construction work begins, submit to the NRC Monitoring Manager for certification, an Offset and Compensation Plan (OCP) prepared by a suitably qualified and experienced ecologist that must include, but not be limited to:

    (a) Planting proposals and plans for environmental enhancement of Te Ruaotehauhau Stream upstream and downstream of Te Ruaotehauhau Water Storage Reservoir, or of other streams in the area; and

    (b) The measures to be undertaken to strengthen and complement the natural vegetation patterns within the site and immediately surrounding area; and

    (c) Terrestrial offset and compensation package which identifies sites where restoration will take place and how, including but not limited to, initial and operational pest plant and animal eradication measures.

    (d) Details on how the effectiveness of the offsetting and compensation measures will be monitored and reported over time.

Water Use

41. The Consent Holder must maintain its water supply reticulation so that it operates effectively at all times and the loss of water from the reticulation network is, as far as is practicable,

minimised. A record of all maintenance must be available to view by NRC's Monitoring Manager immediately on request by that manager.

42. The Consent Holder must prepare a Water Supply Management Plan (WSMP) for the Te Ruaotehauhau Water Storage Reservoir and submit it to the NRC's Monitoring Manager within 12 months of the date of the commencement of these consents. The Water Supply Management Plan must identify the overall water supply strategies to manage the potential effects of the use of water by people who receive water from the Te Ruaotehauhau Water Storage Reservoir under supply agreements.

43. The WSMP must include but not be limited to:

    (a) A general policy on how decisions will be made to supply water to persons from the scheme;

    (b) Identification of allocation quantities to persons as set out under Water Supply Agreements;

    (c) Responsibilities of persons receiving the water to ensure water is conveyed and used efficiently, including the following considerations:

        (i) An assessment of the demonstrated need for water, including current and likely future demand; and

        (ii) Implementation of industry good management practices, taking into account the nature of the activity, to efficiently use water.

44. The WSMP must be reviewed annually from the date of first certification by the NRC to adjust operational practices as necessary to ensure compliance with consent conditions. Any amendments to the WSMP must be provided to the NRC's Monitoring Manager within 10 working days of the change being made.

Reservoir Water Quality

45. At quarterly intervals samples of water from the reservoir must be collected and analysed for the following:

    (a) Five-day biochemical oxygen demand (g/m^3)

    (b) Dissolved inorganic nitrogen (g/m^3)

    (c) Dissolved reactive phosphorus (g/m^3)

    (d) Cyanobacteria (mm^3/L)

(e) Phytoplankton (mg-chlorophyll-a/m^3)

(f) Escherichia coli (cfu/100 mL)

46. All samples must be collected using standard procedures and in appropriate laboratory supplied containers.

47. All samples collected as part of this monitoring programme must be transported in accordance with standard procedures and under chain of custody to the laboratory.

48. All samples collected must be analysed at a laboratory with registered quality assurance procedures, and all analyses are to be undertaken using standard methods, where applicable.

49. By 30 September, the results of monitoring for the previous calendar year must be provided to the NRC's Monitoring Manager.

Review Condition

50. NRC or FNDC may, in accordance with Section 128 of the Resource Management Act 1991, serve notice on the Consent Holder of its intention to review the conditions annually during the month of August for any one or more of the following purposes:

    (a) To deal with any adverse effects on the environment that may arise from the exercise of the consent and which it is appropriate to deal with at a later stage; or

    (b) To require the adoption of the best practicable option to remove or reduce any adverse effect on the environment.

Consent Duration

Land use consents		
Activity	**RMA**	**Duration**
• Erect a dam structure in, on, under, and under the bed of Te Ruaotehauhau Stream[2] • Disturb the bed of Te Ruaotehauhau Stream • Deposit a substance in, or, and under the bed of Te Ruaotehauhau Stream • Reclaim the bed of Te Ruaotehauhau Stream	Section 13	10 years
Water permits		
Activity	**RMA**	**Duration**
• Temporarily divert Te Ruaotehauhau Stream Sduring construction	Section 14	10 years
• Divert and dam freshwater behind the proposed reservoir embankment when catchment inflows exceed the median flows • Divert and dam available 'core allocation' freshwater behind the proposed reservoir embankment outside the irrigation season (May – October)	Section 14	35 years

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[2] Once the embankment is constructed its presence is a permitted activity as it has been lawfully established.

• Divert freshwater through the proposed embankment • Divert freshwater around the proposed embankment (via spillway) • Take and use dammed water		
Discharge permits		
Activity	**RMA**	**Duration**
• Discharge stormwater to water associated with land disturbance activities	Section 15	10 years
• Discharge groundwater from dewatering activities to water	Section 15	10 years