goodearthmatters
sustainable solutions enabling communities

Levin Water Supply
Water Harvesting & Resilience Project

Resource Consent Application and Assessment of Environmental Effects for Abstraction of Water from the Ohau River and Activities to Enable Augmentation of the Levin Water Supply via Water Harvesting & Reservoir Storage

Horowhenua District Council

November 2024

FOR LODGEMENT

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This report has been prepared by Good Earth Matters Consulting Limited on behalf of our client and for the purpose outlined in the project scope. This report is provided for use by our client, their professional advisors and local body authorities for consenting purposes (if applicable). Good Earth Matters Consulting Limited does not accept any liability if this report is used for an alternative purpose from which it is intended, nor to any third party in respect of this report. No liability is accepted by any employee or sub-consultant of Good Earth Matters Consulting Limited.

Client:	Horowhenua District Council		
Report Title:	Resource Consent Application and Assessment of Environmental Effects for Abstraction of Water from the Ohau River and Activities to Enable Augmentation of the Levin Water Supply via Water Harvesting & Reservoir Storage		
File Reference:	27036.101\2024.11 Levin WSR RCA & AEE - FOR LODGEMENT		
Report Issue:	For Lodgement	Date:	November 2024
	Draft - for HDC Review and Approval to Lodge	Date:	August 2024
	DRAFT V2 - update following feedback from Te Tūmatakahuki Advisors	Date:	October 2023
	DRAFT for Project Team and to Inform CIAs	Date:	March 2023

Prepared:	Good Earth Matters Consulting Limited	Date:	November 2024
Reviewer:	Grey Wilson	Date:	November 2024
Authorised for Issue:	Annette Sweeney	Date:	November 2024
On behalf of:	Good Earth Matters Consulting Limited		

Application for **Resource Consent**

Form A: Administration Form

horizons REGIONAL COUNCIL

The purpose of this Administration Form (Form A) and the relevant Activity Information and Assessment Form (Form B) is to provide the applicant with guidance on information that is required under the Resource Management Act 1991. Please note that these forms are to act as a guide only, and Horizons Regional Council reserves the right to request additional information.

Failure to provide the required information and payment will delay the processing of your application. If you do not provide adequate information then we will not be able to process your application, and will return it to you. If you do not pay the required fees, we may stop processing your application until payment is received.

1 APPLICANT DETAILS

CONTACT DETAILS – This section applies to the applicant ONLY. Please use Section 2 for consultant details. Should any of these details change, at any time, please notify us as soon as possible.

For **individuals**, you must provide the full legal names of all individuals (such as John Robert Smith and Mary Jane Williams). For **companies and other incorporated entities** you must provide the company name, registration number and registered office details. You must also provide the name of a person or persons who will represent your company and be responsible for the consent.

For **partnerships and unincorporated entities** (such as private or family trusts or unincorporated societies) we must have the details of all authorised partners, trustees, members or officers. We may also request a copy of your society's rules to verify your status as a formal body or society.

Full legal name/s of applicant . Horowhenua District Council

This is the name/s that the consent will be issued to. There is space in part 2 to complete consultant/contractor details

Director/Chief Executive . Monique Davidson

Company registration number

We will not accept applications made in the name of unregistered companies

Applicant's postal address Private Bag 4002, Levin 5540

Applicant's residential address 126 Oxford Street, Levin 5510

If different from postal address above

Applicant's email address

Applicant's phone number/s

Home Business . 06 366 0999 Mobile Fax

2 APPLICANT CONSULTANT/AGENT DETAILS

(If applicable)

Name/Company name . Good Earth Matters

Contact person . Annette Sweeney

Postal address PO Box 1268, Palmerston North 4440

Email address . annette.sweeney@goodearthmatters.com

Phone number/s

Home Business . 06 353 7560 Mobile . 027 223 5280 Fax

3 PARTNERSHIP/UNINCORPORATED ENTITY DETAILS

For partnerships or unincorporated entities (such as private or family trusts or unincorporated bodies or societies) you must provide details of all authorised partners, trustees or members. Any consent granted will then include these names (where possible), and all individuals will be legally responsible for the consent and any associated costs. Should these persons, or their contact details change, then you must notify us. Include details of all further partners/trustees/members on a separate page if necessary.

Name of person .....

Status .....
(Such as partner or trustee)

Residential address .....

Name of person .....

Status .....
(Such as partner or trustee)

Residential address .....

Name of person .....

Status .....
(Such as partner or trustee)

Residential address .....

4 WHO SHOULD WE SEND APPLICATION CORRESPONDENCE TO?

☐ Applicant ☑ Consultant/Agent

Preferred address for service:

☐ Residential address ☐ Postal Address ☐ DX number ☑ Email ☐ Fax

Note: *All further costs will be invoiced directly to the Applicant unless otherwise specified*

5 RESOURCE CONSENT/S SOUGHT

Please select each of the following consents you are applying for. **Please note all prices are GST inclusive.**

☐ Drilling of a Well
Fixed initial deposit $575.00

☑ Surface Water Take
Fixed initial deposit
Stock Water: $977.50
Irrigation: $1,207.50
Other: $1,150.00

☑ Groundwater Take (Diversion)
Fixed initial deposit
Stock Water: fee $885.50
Irrigation: $1,863.00
Other: $1,115.00

☐ Dairyshed Discharge
Fixed initial deposit $885.50

☐ Land use Intensive Farming and Associated Discharges
Fixed initial deposit $1,725.00

☑ Land Disturbance/Vegetation Clearance (e.g. Earthworks)
Fixed initial deposit $920.00

☐ Land Disturbance/Vegetation Clearance (e.g. Forestry activities including NES Production Forestry)
Fixed initial deposit $920.00

☐ Transfer of Consent
Fixed initial deposit $100.00

☑ Works in a Waterbody
Fixed initial deposit $885.50

☐ Gravel Extraction
Fixed initial deposit $1,667.50

☐ On-site Wastewater discharge
Fixed initial deposit $885.50

☐ Discharge to Air
Fixed initial deposit $1,150.00

☑ Discharge to Land
Fixed initial deposit $885.50

☑ Discharge to Water
Fixed initial deposit $1,150.00

☐ Change of Consent Conditions
Fixed initial deposit
Administration conditions: $500
All other conditions: $885.50

☐ Transfer of activity location
Fixed initial deposit $885.50

☐ Intensive Winter Grazing
Fixed initial deposit $885.50

☐ Other
Fixed initial deposit $885.50

Also refer to Table 2.2 in attached AEE.

5A PROVIDE A BRIEF DESCRIPTION OF THE ACTIVITY TO WHICH THIS APPLICATION RELATES

- A new water permit to enable water storage to be provided within the Levin water supply network (via use of the new reservoir) to replace the existing water take permits and to enable use of water for construction of O2NL SH1 project.
- Construction, operation and maintenance of a new intake structure and associated riparian works in order to improve optionality within the Levin Water Supply network and address and improve operational issues being experienced at the existing water treatment plant intake as well as to reduce adverse effects to the river bed associated with maintenance of the existing intake
- Construction (large scale earthworks) of reservoir including land disturbance impacting a natural inland wetland.
- Construction and use of a new pipeline bridge to enable connection of the new reservoir to the existing water treatment plant
- Intermittent discharge of overflow from the reservoir
- Diversion and discharge of groundwater from under the reservoir.

Refer to attached AEE for details.

5B EFFECT ON STATUTORY ACKNOWLEDGMENTS

Is the activity on, adjacent to, or may affect land that is subject of a statutory acknowledgment? ☐ Yes ☑ No

List of statutory acknowledgments:
Ngāti Tūwharetoa (Bay of Plenty) Claims Settlement Act 2005
Ngaa Rauru Kiitahi Claims Settlement Act 2005
Ngāti Apa (North Island) Claims Settlement Act 2010
Rangitāne o Manawatu Claims Settlement Act 2016
Rangitāne Tū Mai Rā (Wairarapa Tamaki nui-ā-Rua) Claims Settlement Act 2017
Ngāti Rangi Claims Settlement Act 2019

Information on statutory acknowledgments can be found on the Horizons website: **https://www.horizons.govt.nz/about-our-region-and-council/iwi-and-hapu**

If yes, Council must have regard to the statutory acknowledgments. We recommend that applicants considering undertaking works that may affect a statutory acknowledgment make contact with local iwi and/or hapū before the lodgement of a consent application to determine if there are any effects on the statutory acknowledgment.

5C TE AWA TUPUA (WHANGANUI RIVER CLAIMS SETTLEMENT) ACT 2017

Are the proposed works in the Whanganui catchment? ☐ Yes ☑ No

Please note that this covers a large area. If you are unsure, please contact the consents team.

If yes, the Whanganui River and its wider catchment is the subject of the Te Awa Tupua (Whanganui River Claims Settlement) Act 2017. Council must have regard to the values of Te Awa Tupua when making a decision on any application we receive (regardless of activity status). On that basis, we recommend that parties undertaking works within the Whanganui catchment make contact with Ngā Tāngata Tiaki o Whanganui and local iwi and/or hapū before lodgment of a consent application to confirm any requirements under Te Awa Tupua and obtain feedback on the proposed works.

5D TE WAIŪ-O-TE-IKA - WHANGAEHU RIVER (NGĀTI RANGI CLAIMS SETTLEMENT ACT 2019

Are the proposed works in the Whangaehu catchment? ☐ Yes ☑ No

Please note that this covers a large area. If you are unsure, please contact the consents team.

If yes, the Whangaehu River and its wider catchment is the subject of the Te Waiū-o-Te-Ika (Ngāti Rangi Claims Settlement Act 2019). Council must have regard to the values (Te Mana Tupua and Ngā Toka Tupua) of Te Waiū-o-Te-Ika when making a decision on any application we receive (regardless of activity status). On that basis, we recommend that parties undertaking works within the Whanganui catchment make contact with local iwi and/or hapū before lodgment of a consent application to confirm any requirements under Te Waiū-o-Te-Ika and obtain feedback on the proposed works.

5E **ARE THERE ANY CURRENT OR EXPIRED CONSENTS RELATING TO THIS PROPOSAL?**
If yes, please provide consent number(s) and description.

☑ YES ☐ NO

ATH-19910060l1.03; ATH-2022203743.00; ATH-2008010962.02; ATH-1995003230.01.

Refer Table 2.1 in attached Assessment of Environmental Effects.

5F **IF THIS IS A RENEWAL OR REPLACEMENT APPLICATION, DO YOU AGREE TO SURRENDER YOUR CURRENT CONSENT SHOULD THIS APPLICATION BE GRANTED?**

☑ YES ☐ NO

Surrender of ATH-19910060l1.03 and ATH-202203743.00
Retain ATH-2008010962.02 and ATH-1995003230.01

5G **ARE THERE ANY OTHER CONSENTS REQUIRED FROM HORIZONS REGIONAL COUNCIL?**
If yes, please state the type of consent required and status.

☐ YES ☑ NO

5H **DO YOU REQUIRE ANY OTHER RESOURCE CONSENT FROM ANY LOCAL AUTHORITY FOR THIS ACTIVITY?** If yes, please state the relevant authority, type of consent required and status.

☐ YES ☑ NO

Proposed works are considered to be a Permitted Activity under the Horowhenua District Plan. That notwithstanding, the reservoir site is proposed to be designated via a Notice of Requirement.

6 **VALUE OF INVESTMENT (RENEWAL APPLICATIONS ONLY)**

Please complete this section ONLY if your application is to renew an existing consent. Select the value below of your investment which is dependent on this consent. Please note this must be on the book/market value (as opposed to replacement value).

☐ < $10,000 ☐ $50,000 TO $250,000 ☐ $1M TO 5 M ☐ >$50 M

☐ $10,000 – 50,000 ☐ $250,000 - $1,000,000 ☐ $5M - $50M ☐

If the scope of the investment relating to the activity(ies) which is reliant on the granting of this application is significant, you will need provide evidence of this valuation with the application; such as a valuation or other credible indication of current/recent market value.

7 LOCATION OF PROPOSED ACTIVITY

Is the activity in a coastal marine area? ☐ **YES** ☑ **NO**
(As defined in the RMA 1991)

Property address .... Refer to Assessment of Environmental Effects. .....

Legal description
(This can be found on your rates invoice) Refer to Assessment of Environmental Effects.

Valuation number/s

.... Refer to Assessment of Environmental Effects .....

Map reference (NZTM 2000) .... Refer to Assessment of Environmental Effects .. E ..... N .....
(If known)

7A IF THE OWNER AND/OR OCCUPIER OF THE ACTIVITY SITE DIFFERS FROM THE APPLICANT, PLEASE PROVIDE THEIR NAMES AND CONTACT DETAILS

Owner Name .....

Postal address

.....

Email address .....

Phone number/s

Home ..... Business ..... Mobile ..... Fax .....

Please note that written approval is required from this landowner and should accompany this application.

8 FIXED INITIAL DEPOSIT FOR APPLICATION

Please refer to the table in Section 5 for the relevant lodgement fee required with your application.

This fee is **REQUIRED** when an application is submitted and is an initial deposit towards the final cost of processing the application. Failure to pay the fee upon lodging your application may result in rejection of your application.

Please note that this initial deposit payment may not cover the full cost of processing the application. In accordance with Section 36(3) of the RMA, Council reserves the right to recover actual and reasonable costs for consent applications where the costs exceed the initial preliminary deposit. In some instances, where additional information is sought by either party, costs can increase and additional charges may be invoiced. Any additional charges will be payable in accordance with the schedule of additional charges laid out in our Annual Plan. Any additional costs will be invoiced following a decision on your application.

If a refund is due, you will be notified by letter or email advising you of the process to receive this.

Payment Methods for Deposit

- Internet banking to Horizons Regional Council bank account (see below)
- Over the counter – payments can be made at any of our offices listed on our website, using credit card, EFTPOS or cash

Please note – you will be liable for any current charges associated with this consent up until Horizons Regional Council receives a surrender or transfer form.

Name of account	Bank	Branch	Account No.	Suffix
Horizons Regional Council	02	0630	0024883	003

Note:
Payer Particulars – Applicant surname or party making payment on behalf of applicant
Payer Code – CONSENTS
Payer Reference – Company name or surname of applicant

Please write below what you have entered for the PayerCode/Payer Reference details when making your deposit online.

Payer Particulars	Payer Code	Payer Reference – Name of Applicant
	C O N S E N T S	

Total amount paid $ .. 20.000 ..... Payment date .....

Is the Council required to quote a purchase order number on future invoices for this application?
All Local and Central Government Agencies will require a Purchase Order

☑ Yes ☐ No Order Number . PO143836 .....

Deposit fee to be invoiced to Horowhenua District Council as per email from Sara Westcott to Annette Sweeney dated 20 August 2024. Please quote PO 143836 on invoice.

9 FINAL CHECKLIST

Have you attached the following?

- ☑ Activity Information and Assessment form/s as ticked above (Form B)
- ☑ Detailed map showing location and all required points of reference as requested on the activity application form.
- ☐ Fixed initial deposit payment Horizons to invoice Horowhenua District Council

If you have already dealt with a member of Horizons Regional Council regarding your application, please specify their name.

.....Sara Westcott.....

Please contact the consents team on freephone **0508 800 800** if you require assistance with your application.

10 APPLICANT DECLARATION

I .Annette Sweeney.....confirm the information contained within this application and additional information is true and correct at the time of submission.

Signature of applicant..... Date ...21/11/2024.....

(Or person authorised to sign on behalf of the applicant)

Please email your application to **regulatory.administrator@horizons.govt.nz** or alternatively you can post your application to:

Horizons Regional Council
11-15 Victoria Avenue
Private Bag 11025
Manawatu Mail Centre
Palmerston North 4442

IMPORTANT INFORMATION – PLEASE READ CAREFULLY

Official Information

Horizons Regional Council takes your privacy seriously. Any information you provide with this application, including documentation provided in support of your application, is official information. It will be used to process your resource consent application and, together with other official information, assist in the management of the region's natural and physical resources.

This information will be held and administered by Horizons Regional Council in accordance with the Local Government Official Information and Meetings Act 1987 and the Privacy Act 1993.

Your information may be disclosed in accordance with the terms of these Acts. It is therefore important you advise the Council if your application includes trade secrets and/or commercially sensitive material. You have the following rights with regard to the information held about you:

- To access your personal information.
- To request incorrect information to be amended.
- To expect the information to be safely stored and used by or disclosed to authorised users only.
- To expect your personal information to be accurate and consistent in accordance with sound practices of record keeping and information systems management.

Failure to provide the necessary information will mean that Horizons Regional Council will be unable to process your application.

Consent Holder Costs – All Consents

Once granted, most resource consents will incur an annual research and monitoring charge and a compliance monitoring charge pursuant to Section 36 of the Resource Management Act. Application charges involve payment of an initial fixed deposit (minimum application fee) at the time an application is lodged with Council. Where an application is to be limited or publicly notified, a further fixed deposit is required to be paid to Council one week prior to notification occurring. In instances where the total cost of processing an application is not fully covered by the fixed deposit(s), an additional charge(s) will be made under Section 36(5) of the RMA to recover the actual and reasonable costs incurred by the Council in carrying out its statutory functions.

Ongoing Responsibilities

If your application is granted you will be responsible for complying with your consent conditions and payment of your consent charges until your consent expires. If you wish to cancel (surrender) your consent, transfer responsibility to another party, or make changes to your consented activity before it expires, you must submit notice to us in writing or make an application to change your consent.

Application for **Resource Consent: Surface Water Take**

horizons REGIONAL COUNCIL

Form B: Activity Information and Assessment Form

A complete Administration Form (Form A) MUST accompany this Activity Information and Assessment Form (Form B) when lodging your application. The purpose of this form is to provide the applicant with guidance on information that is required under the Resource Management Act 1991. These forms are to act as a guide only, and Horizons Regional Council reserves the right to request additional information.

! PLEASE READ THE FOLLOWING BEFORE COMPLETING THIS FORM

Before submitting this application you will need confirmation of whether the proposed volume of water sought is available as per the cumulative core allocation limits set out in RP-SCHED3. To determine this you will need to email surfacewater@horizons.govt.nz and specify:

- Name
- Address
- Contact phone number
- Location of Activity (please be as accurate as possible, if needed you can mark this abstraction point on a map)
- Surface water management area as identified in RP-SCHED1
- Volume of water sought
- Purpose

Please allow 2-3 working days for a reply and supply a copy of the response as part of the application.

APPLICANT NAME Horowhenua District Council

(Refer to Form A)

1 APPLICATION PURPOSE

What is the purpose of this application (select one)

- (●) New consent
- ( ) Renewal of consent

Consent number ..... Expiry date.....

Consent term sought 35 years

(Max. 35 years)

Note: Resource consents are typically aligned with the relevant common catchment expiry dates in Policy IP-P5 of the One Plan.

2 LOCATION AND SITE DETAILS

Address

Refer to Assessment of Environmental Effects.

Legal description

Refer to Assessment of Environmental Effects.

Map reference of proposed abstraction (NZTM 2000) E Refer to attached AEE N Refer to attached AEE

What type of surface waterbody/s do you intend to take water from?

(●) River/stream/creek ( ) Spring ( ) Pond/ dam ( ) Lake

What is the name of the waterbody/s of the proposed take/s?

If the water body is unnamed then please note this and state which waterbody it is a tributary of.

Refer to Assessment of Environmental Effects.

According to RP-SCHED1 of the One Plan, what Surface Water Management Area is this in?

Refer to Assessment of Environmental Effects.

You can access this information via http://www.horizons.govt.nz/publications-feedback/one-plan/part-3-annexes/schedules.

3 DESCRIPTION OF PROPOSED ACTIVITY

What will be the maximum rate at which water is taken? Refer to Assessment of Environmental Effects.

..... litres per second

..... m^3/day (cubic metres per day)

..... m^3/year (cubic metres per year, accounting for leap years where there is 366 days)

What is the proposed use of the water abstracted? Refer to Assessment of Environmental Effects.

( ) Irrigation *(please complete Table 1 below)*

( ) Domestic water supply *(please complete Table 2 below)*

( ) Stockwater/dairyshed washdown *(please complete Table 3 below)*

( ) Municipal supply

( ) Industrial *(please complete Table 4 below)* .....

( ) Other *(please complete Table 4 below)* .....

TABLE 1 IRRIGATION N/A

What is the area/s you will be irrigating?

☐ Crop(s) ..... ha TOTAL Crop type .....
..... ha/day

☐ Pasture..... ha TOTAL
..... ha/day

☐ Horticulture..... ha Horticulture type.....
..... ha/day

☐ Other ..... ha Please specify .....
..... ha/day

Please ensure the area to be irrigated is marked on the site map required under Section 4.

Target application rate ..... mm/day

TABLE 3 STOCKWATER USAGE *(Please fill out the following table)*

Animal type/use	Number of individuals	Maximum reasonable use volume (L/individual/day)	Total water allowance (L/day)	Total water allowance (m3/day)
Dairy cow drinking water only		70		
Dairy shed washdown (per cow)		70		
Dairy cow (dry or replacement stock)		45		
Calves		30		
Beef cattle (mature cattle, herd replacement stock and bulls)		55		
Sheep		4.5		
Horses (working)		70		
Horses (grazing)		50		
Deer (hinds and stags - all ages)		12		
Goats (dairy - in milk)		10		
Goats (dry)		7		
Pigs (mature)		18		
Pigs (brood sow)		35		
Poultry (layer and breeder hens)		0.45		
Poultry (non-laying hens and chickens)		0.29		
Turkeys		0.1		
Domestic (per person)		300		
			TOTAL	

The water use requirements in this calculator are maximum likely requirements (or peak daily demand) and are based on the recommendations of Stewart & Rout (2007). Volumes calculated within these guidelines are considered to meet Horizons "reasonable use" criteria, although water use efficiency and best practice , particularly in relation to dairy shed washdown water, is expected and encouraged.

If you consider you are using more or less than those figures in the above table, please provide the calculations below.

TABLE 4 INDUSTRIAL USE/OTHER

What type of Industry/other use will be using the water and how will the water be used?

Refer to Assessment of Environmental Effects

How have you calculated the volume of water you need? *Please provide any best practice or industry standards used.*

Refer to Assessment of Environmental Effects

Do you take water from any other sources on your property for other purposes? If yes, please provide details.

Refer to Assessment of Environmental Effects

WATER MEASURING AND REPORTING INFORMATION Refer to Assessment of Environmental Effects.

Is there a water meter installed on the pump? ◯ Yes ◯ No

If 'No', when do you plan to install a water meter? .....

Is there a backflow preventer installed? ◯ Yes ◯ No

Is there telemetry installed? ◯ Yes ◯ No

If there is a water meter, please answer questions below

What is the flow meter type? ◯ Magflow ◯ Ultrasonic ◯ Mechanical ◯ Other

What is the flow meter brand type?.....

Is the meter *(please select one)* ◯ In situ ◯ On a mobile unit

Has the water meter been verified? ◯ Yes ◯ No

If 'Yes', who verified the water meter and when?

Please attach a copy of the verification certificate.

What is the method of abstraction *(E.g. suction hose, infiltration gallery etc).* Please attach a photo of the setup of the take.

Is the intake screened? ◯ Yes ◯ No

If 'Yes', what is the minimum mesh size? .....(mm)

4 EFFECT ON STATUTORY ACKNOWLEDGMENTS

Is the activity on, adjacent to, or may affect land that is subject of a statutory acknowledgment? ☐ Yes ☑ No

List of statutory acknowledgments:
Ngāti Tūwharetoa (Bay of Plenty) Claims Settlement Act 2005
Ngaa Rauru Kiitahi Claims Settlement Act 2005
Ngāti Apa (North Island) Claims Settlement Act 2010
Rangitāne o Manawatu Claims Settlement Act 2016
Rangitāne Tū Mai Rā (Wairarapa Tamaki nui-ā-Rua) Claims Settlement Act 2017
Ngāti Rangi Claims Settlement Act 2019

Information on statutory acknowledgments can be found on the Horizons website: **https://www.horizons.govt.nz/about-our-region-and-council/iwi-and-hapu**

If yes, Council must have regard to the statutory acknowledgments. We recommend that applicants considering undertaking works that may affect a statutory acknowledgment make contact with local iwi and/or hapū before the lodgement of a consent application to determine if there are any effects on the statutory acknowledgment.

5 TE AWA TUPUA (WHANGANUI RIVER CLAIMS SETTLEMENT) ACT 2017

Are the proposed works in the Whanganui catchment? ☐ Yes ☑ No
Please note that this covers a large area. If you are unsure, please contact the consents team.

If yes, the Whanganui River and its wider catchment is the subject of the Te Awa Tupua (Whanganui River Claims Settlement) Act 2017. Council must have regard to the values of Te Awa Tupua when making a decision on any application we receive (regardless of activity status). On that basis, we recommend that parties considering undertaking works within the Whanganui catchment make contact with Ngā Tāngata Tiaki o Whanganui and local iwi and/or hapū before lodgement of a consent application to confirm any requirements under Te Awa Tupua and obtain feedback on the proposed works.

6 TE WAIŪ-O-TE-IKA - WHANGAEHU RIVER (NGĀTI RANGI CLAIMS SETTLEMENT ACT 2019)

Are the proposed works in the Whanganui catchment? ☐ Yes ☑ No
Please note that this covers a large area. If you are unsure, please contact the consents team.

If yes, the Whangaehu River and its wider catchment is the subject of Te Waiū-o-Te-Ika (Ngāti Rangi Claims Settlement Act 2019). Council must have regard to the values (Te Mana Tupua and Ngā Toka Tupua) of Te Waiū-o-Te-Ika when making a decision on any application we receive (regardless of activity status). On that basis, we recommend that parties considering undertaking works within the Whangaehu catchment make contact with local iwi and/or hapū before lodgement of a consent application to confirm any requirements under Te Waiū-o-Te-Ika and obtain feedback on the proposed works.

7 RULE ASSESSMENT

To determine if your application will be assessed as a controlled activity for which consent must be granted (Rule LF-TUD-R43), or a discretionary activity (Rule LF-TUD-R45) or non-complying activity (Rule LF-TUD-R47) for which consent may or may not be granted, we need to understand if your proposed activity meets all of the conditions of Rule LF-TUD-R43.

Please explain how you meet or do not meet the relevant conditions, a blank space will not be accepted.

Conditions/Standards/Terms	Yes/No/N/A	Explanation of how you meet the condition
Water^ must only be taken when the river^ is above its minimum flow, as assessed in accordance with RP-SCHED3.	☐ Yes ☐ No ☐ N/A	Refer to Assessment of Environmental Effects
The amount of water^ taken, when assessed in combination with all other water^ takes must not exceed the relevant cumulative core allocation limits set out in RP-SCHED3.	☐ Yes ☐ No ☐ N/A	*You will need to email the science team at surfacewater@horizons.govt.nz to verify whether the proposed abstraction volume is within the core allocation. Please attach a copy of the response to your application.* Refer to Assessment of Environmental Effects
The amount of water taken from a river^ must not lower the water^ level in any wetland^ that is a rare habitat* or threatened habitat*.	☐ Yes ☐ No ☐ N/A	Refer to Assessment of Environmental Effects
The take must not be from any rare habitat*, threatened habitat* or at-risk habitat*.	☐ Yes ☐ No ☐ N/A	Refer to Assessment of Environmental Effects

**Further information on rare, threatened or at-risk habitats can also be found in RP-SCHED6 of the One Plan, which can be accessed via http://www.horizons.govt.nz/publications-feedback/one-plan/part-3-annexes/schedules.*

Please select the appropriate activity status from the options below.

◉ The proposed activity is **not** in a rare habitat, threatened habitat or at-risk habitat. Your application is a **controlled activity**, you can proceed to fill out this form to complete your application, including an appropriate assessment of environmental effects.

○ The proposed activity is in a rare habitat, threatened habitat or at-risk habitat. Your application is either a **discretionary activity or a non-complying activity**. A full assessment of environmental effects, prepared by a suitably qualified person must accompany your application, appropriate to the scale of the non-compliance with the rules above.

Note: as per AEE, water take is a Non-Complying Activity given abstraction below minimum flow AND supplementary allocation sought.

Explain how you have determined that the volume requested is reasonable for the needs of your crop/horticulture. *(E.g. comment on any calculations or experience)*. If based on an efficiency assessment by an industry professional, please provide documentation of this.

Irrigator type .....

Please advise if you intend to irrigate daily or on a rotational schedule. Please detail the schedule.

If you already hold a consent, have you changed or upgraded your irrigation system since that consent was granted? ◯ Yes ◯ No

If 'Yes', please specify how.

Please describe the soil type and characteristics for the area to be irrigated.

TABLE 2 DOMESTIC WATER SUPPLY N/A

Please select the type of facility

☐ Private dwelling/s
Number of dwellings ..... Maximum occupancy .....

☐ Commercial/rural *(E.g. dairyshed, woolshed etc.)*
Description ..... Occupancy.....

☐ School
Maximum occupancy .....

☐ Camping Ground
Maximum occupancy including staff .....

☐ Marae
Maximum number of day visitors ..... Overnight visitors .....

☐ Other
Please describe and include maximum occupancy

8 ASSESSMENT OF ENVIRONMENTAL EFFECTS

For your application to be considered, an assessment of effects must be included. Please answer all questions below. Additional information may need to be provided and/or assistance needed from a specialist depending on the scale and significance of your proposal.

Does your proposed abstraction volume fit within the core allocation limits set out in RP-SCHED3? ◉ Yes ○ No

If 'No', please detail what potential effects this may have and how these may be mitigated.

Refer to Assessment of Environmental Effects

Do you agree that you will not abstract any water below the dictated minimum flow set out in RP-SCHED3? ○ Yes ◉ No

If 'No', please provide reasons for this and detail what the potential effects of taking below minimum flow may be, and how these will be mitigated.

Refer to Assessment of Environmental Effects

Do you consider that there will be any other effects on the environment? ○ Yes ○ No
(For example cultural effects, instream ecological effects, or effects on riparian vegetation).

Please provide reasons for your answer above.

Refer to Assessment of Environmental Effects

9 GOOD MANAGEMENT PRACTICES AND MITIGATION MEASURES

Please include a description of the monitoring or good management practices to be undertaken to help avoid, reduce, remedy or mitigate the actual and potential effects on the environment.

Please describe any measures you are proposing to minimise wastage of water and maximise its efficient use.
(E.g. use of storage, variable rate irrigation, soil moisture monitoring, leak detection).

Refer to Assessment of Environmental Effects

What measures will you take during periods of low flows (minimum flow restrictions)?

Refer to Assessment of Environmental Effects

Are there any other measures that you intend to implement to prevent any potential effects on instream values?
(E.g. fish screens, maintenance, riparian planting, cultural effects if intending to take below minimum flow).

Refer to Assessment of Environmental Effects

10 CONSIDERATION OF ALTERNATIVES

Have you considered the option of using any alternative sources of water?

(●) Yes *(please specify)* Refer to Assessment of Environmental Effects

( ) No

Explain why you have decided to take from the proposed water resource rather than any of the alternatives *(if any)*.

Refer to Assessment of Environmental Effects.

11 NATIONAL ENVIRONMENTAL STANDARDS

NATIONAL ENVIRONMENTAL STANDARDS FOR SOURCES OF HUMAN DRINKING WATER (NES-HDW)

Are there any public water supplies that could be affected by the take? (●) Yes ( ) No

An assessment under the NES-HDW will need to identify any sources of human drinking water that supply more than 25 people that might be affected by the discharge. Horizons Regional Council holds a list of such water supplies within its region and will be able to provide assistance when identifying water supplies within the vicinity of the activity.

Discussion with the water supply operator may be beneficial in determining whether the supply could be affected and what measures can be taken to ensure the quality of the water supply is maintained.

Refer to Assessment of Environmental Effects.

Note: Public water supply 'affected' is the same as the activity for which consent is sought.

RESOURCE MANAGEMENT (MEASUREMENT AND REPORTING OF WATER TAKES) REGULATIONS 2010

Does your proposed activity meet all the requirements of the above named regulations? (●) Yes ( ) No

NOTE: Standard consent conditions for water takes include all the requirements.

Refer to Assessment of Environmental Effects

Please state any other NES that you consider may be relevant to your activity and provide an assessment against that NES.

Refer to Assessment of Environmental Effects

12 RELEVANT STATUTORY PROVISIONS

The Resource Management Act 1991 requires this application to include an assessment of the proposed activity against the One Plan. Answering the following questions will satisfy this requirement. If you are unable to answer the questions below, or you believe your proposal is inconsistent with the relevant policies and documents discussed, it is recommended you seek professional planning assistance to help you with your application. For a complete copy of the One Plan visit *http://www.horizons.govt.nz/publications-feedback/one-plan.*

REGIONAL POLICY ASSESSMENT

The objectives and policies of the 'Resource Management Issues of Significance to Hapu and Iwi' (RPS-RMIA) chapter and the 'Land and Freshwater' (RPS-LF-FW) chapter are relevant to this application.

Is the activity consistent with the relevant provisions of the Regional Policy Statement? (●) Yes ( ) No

Please provide reasons for your answer above

Refer to Assessment of Environmental Effects

Please list any other relevant objective and /or policies of the Regional Policy Statement and provide an assessment of the activity against those objectives and/or policies.

Refer to Assessment of Environmental Effects

REGIONAL PLAN ASSESSMENT

Objective LF-TUD-O4 and Policies LF-TUD-P13, LF-TUD-P14, and LF-TUD-P20 of the 'Land and Freshwater' (RP-LF-TUD) of the Regional Plan are relevant to this application.

Is the activity consistent with the relevant provisions of the Regional Plan? (●) Yes ( ) No

Please provide reasons for your answer above

Refer to Assessment of Environmental Effects

If there are other sections of the One Plan or any national planning document (e.g. NZ Coastal Policy Statement, National Policy Statement for Freshwater Management) that you consider are relevant, please provide an assessment of the activity against those relevant objectives/policies of the One Plan and/or national document.

Refer to Assessment of Environmental Effects

13 ADDITIONAL INFORMATION REQUIRED WITH THIS FORM

- [x] Administration Form (Form A)
- [x] A SITE map to scale showing:
  - The geographical location of the property
  - The location of the water body
  - The location of the proposed abstraction point/s
  - The total property area boundary
  - Location of pump/pump shed
  - Existing or proposed flowmeter location
  - Where the water is to be used i.e. irrigation area, industrial use etc
  - Distances to any discharge activities
  - Mark any rare, threatened or at risk habitats in the vicinity of the take
  - The coastline and the distance to it (if relevant)
- [ ] Water meter verification certificate (if available)
- [ ] Photo of water take point
- [ ] Evidence of volume and efficiency calculations
- [ ] Soil map of the proposed irrigation area (if applicable)

Please contact the consents team on freephone **0508 800 800** if you require assistance with your application.

Application for Resource Consent:
Works in a Waterbody Including structures, bridges or culverts

horizons REGIONAL COUNCIL

Form B: Activity Information and Assessment Form

A complete Administration Form (Form A) MUST accompany this Activity Information and Assessment Form (Form B) when lodging your application. The purpose of this Form is to provide the applicant with guidance on information that is required under the Resource Management Act 1991. These forms are to act as a guide only, and Horizons Regional Council reserves the right to request additional information.

Before filling out this form, please ensure that your proposed activity requires consent under the One Plan. Many of the activities under the 'Land and Freshwater' (RP-LF-AWBD) chapter are a permitted activity as long as you can meet certain conditions and standards. Some conditions are specific to the activity, and there are also 'general conditions' that apply to all permitted activities.

APPLICANT NAME Horowhenua District Council
(Refer to Form A)

1 APPLICATION PURPOSE

What is the purpose of this application (select one)

☑ New consent

☐ Renewal of consent

Consent number ..... Expiry date .....

Please describe what is it you wish to do? Refer to Assessment of Environmental Effects
(E.g. build a bridge, install a culvert etc.)

Consent term sought 35 years
(Max. 35 years)

Note: Resource consents are typically aligned with the relevant common catchment expiry dates in Policy IP-P5 of the One Plan. Once constructed, the ongoing use and maintenance of the structure is a Permitted Activity under Rule LF-AWBD-R57 and/or LF-AWBD-R58 of the One Plan.

2 LOCATION AND SITE DETAILS

General address Refer to Assessment of Environmental Effects

Which river or waterway is your proposed activity connected with? Refer to Assessment of Environmental Effects
(If the waterway is unnamed, then please state this and name the stream/river it eventually flows into)

According to RP-SCHED1 of the One Plan, what Surface Water Management Area is this in?
Refer to Assessment of Environmental Effects

You can access this information via http://www.horizons.govt.nz/publications-feedback/one-plan/part-3-annexes/schedules

Please provide GPS grid references of the proposed activity location/s Refer to Assessment of Environmental Effects

Location 1:
Grid reference (NZTM 2000) E ..... N .....

Location 2:
Grid reference (NZTM 2000) E ..... N .....

Location 3:

Grid reference (NZTM 2000) E..... N .....

A detailed site map is required with this application, please see Section 4 - additional information required.

Please provide a detailed description of the location of your proposed activity

Describe the physical attributes of the site (e.g. topography, ecology, bed materials, wildlife habitats, recorded archaeological sites and other significant features). Please attach any maps accordingly.

It would also be useful to provide colour photographs of the proposed activity location looking both up and downstream.

(Note: Please indicate on each photograph the direction the photographer is facing, the location the photograph is taken from, and the date it was taken).

Refer to Assessment of Environmental Effects

3 DESCRIPTION OF THE PROPOSED ACTIVITY

Description of activity *(tick all that apply)*

- ☐ Erect, reconstruct, place, alter, extend, remove, or demolish any structure or part of any structure in, on, under, or over the bed of a stream or river.
- ☐ Excavate, drill, tunnel, or otherwise disturb the bed of a stream or river.
- ☐ Deposit any substance in, on, or under the bed of a stream or river.
- ☐ Reclaim or drain the bed of a stream or river.
- ☐ Wetland disturbance.
- ☐ Other (please specify) .....

Please describe the proposed activity

Purpose of activity

Refer to Assessment of Environmental Effects

Materials to be used

Refer to Assessment of Environmental Effects

Duration and timing of works

Refer to Assessment of Environmental Effects

Machinery to be used

Refer to Assessment of Environmental Effects

How will the site be accessed?

Refer to Assessment of Environmental Effects

COMPLETE THE SECTION BELOW ONLY IF YOU ARE CONSTRUCTING A BRIDGE

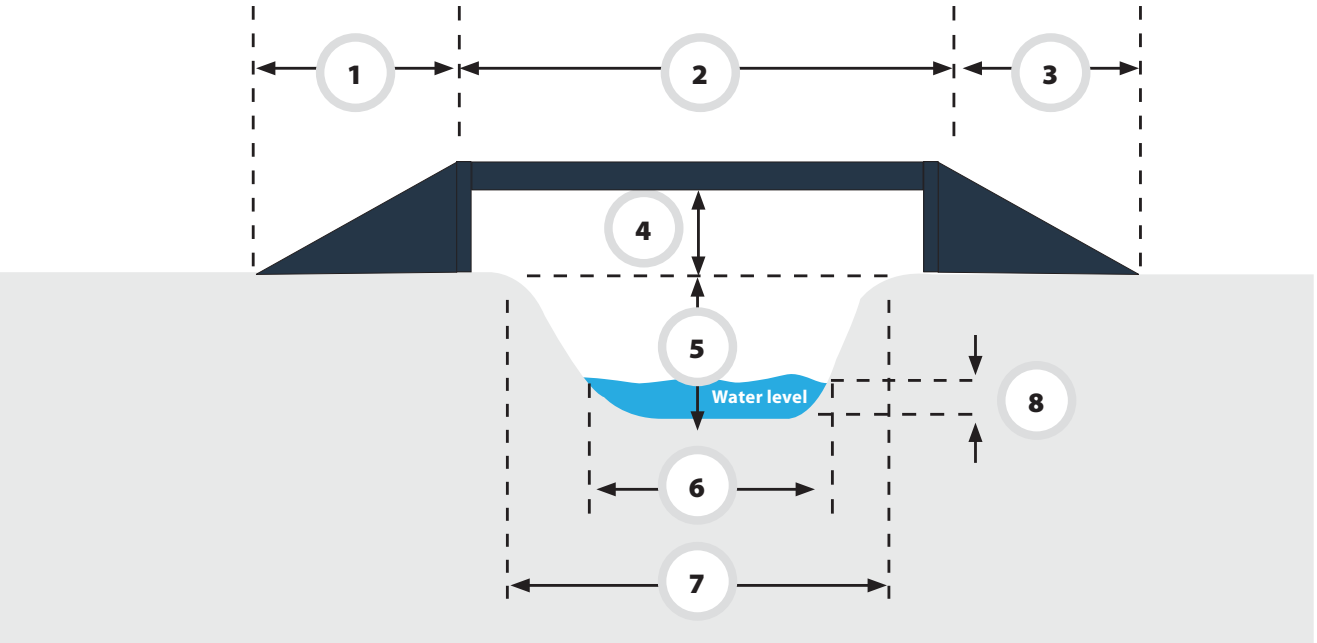
Alternatively you can provide the information detailed below in a separate plan. Refer to Assessment of Environmental Effects

Bridge construction, placement, and use.

Location of bridge abutments

☐ Outside banks of waterway ☐ Inside banks of waterway ☐ In bed of waterway

Please fill in the dimensions shown in the list below.



1. Length of bridge approach ..... m
2. Length of bridge ..... m
3. Length of bridge approach ..... m
4. Height of bridge underside above natural ground level ..... m
5. Height of natural ground level above stream bed ..... m
6. Bed width of stream channel ..... m
7. Top width of stream channel ..... m
8. Average depth of water in the stream ..... m

If there is to be a spillway, please indicate its dimensions

Depth of spillway ..... m

Width of spillway ..... m

How have you determined the waterway capacity of the proposed bridge is adequate?
(Tick the applicable box)

- ☐ Engineers calculations (attached)
- ☐ Ministry for the Environment Guidelines *(refer to: http://www.mfe.govt.nz/publications/land/culvertbridge-oct04/culvert-bridge-oct04.pdf)*
- ☐ Other method detailed below

Refer to Assessment of Environmental Effects

COMPLETE THE SECTION BELOW ONLY IF YOU ARE CONSTRUCTING A CULVERT.

Culvert construction and use

What is the proposed culvert made of *(e.g. concrete, PVC, etc.)* .....

Length of culvert ..... m

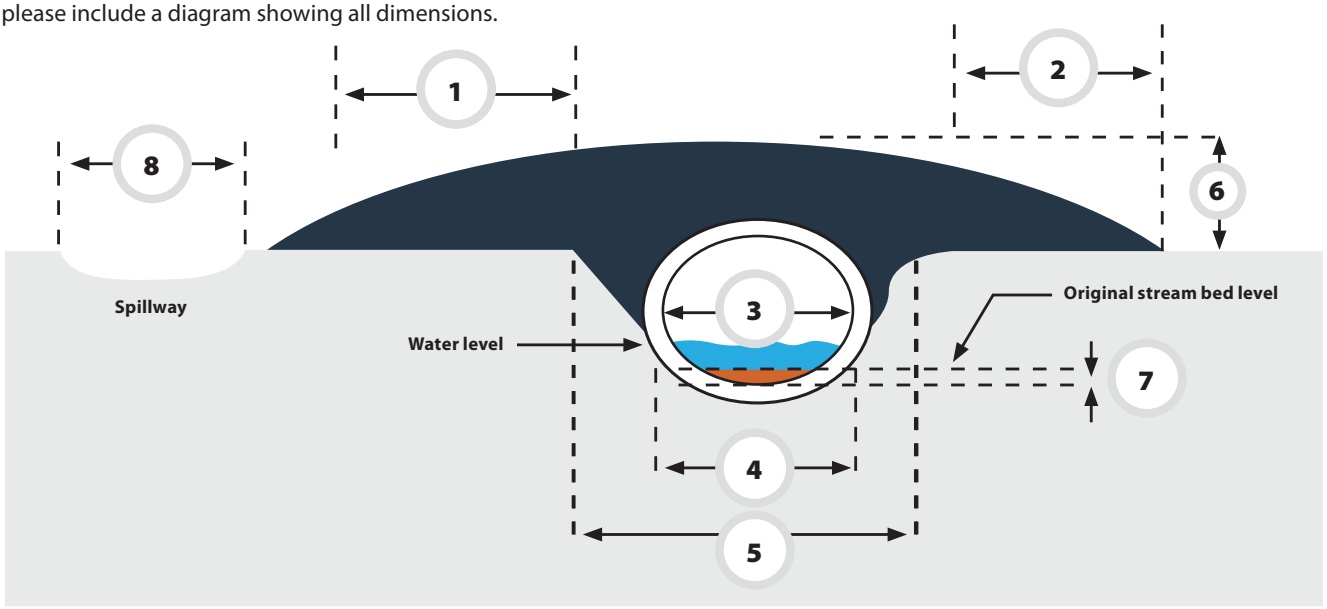
Number of barrels .....

Gradient at which culvert will be laid in the stream bed .....

Surface material of spillway, if required *(e.g. rock, grass, geotextile)* .....

Proposed fill material .....

Please fill in the dimensions shown on the diagram in the list below. If the culvert design is different from that shown below, please include a diagram showing all dimensions.



1. Length of culvert approach ..... m
2. Length of culvert approach ..... m
3. Circular culvert diameter ..... m
   OR Box culvert width ..... m height ..... m
4. Bed width of original stream channel ..... m
5. Top width of original stream ..... m
6. Depth of fill over culvert ..... m
7. Depth of culvert base below original stream bed level ..... m
8. Spillway width ..... m

How have you determined the waterway capacity of the proposed culvert is adequate?

- ☐ Engineers calculations (attached)
- ☐ Ministry for the Environment Guidelines *(refer to: http://www.mfe.govt.nz/publications/land/culvertbridge-oct04/culvert-bridge-oct04.pdf)*
- ☐ Other method detailed below

COMPLETE THIS SECTION FOR OTHER IN-STREAM WORKS

Including bank stabilisation, erosion protection features, retaining works, fords, pipes etc.

Please provide detailed structural plans which

Refer to Assessment of Environmental Effects

- ☐ Are to scale;
- ☐ Show dimensions; and
- ☐ Show length and width of the bed and banks that will be affected.

4 RULE ASSESSMENT

Many activities under the 'Land and Freshwater' (RP-LF-AWBD) chapter of the One Plan are permitted activities as long as you can meet certain conditions and standards. Some conditions are specific to the activity, and there are also 'general conditions' that apply to all permitted activities. Please ensure your activity is not a permitted activity under the 'Land and Freshwater' (RP-LF-AWBD) chapter of the One Plan.

There are a number of guideline documents which can help you determine the activity status available via *http://www.horizons.govt.nz/publications-feedback/publications/one-plan*. If you still require assistance, please contact the consents team freephone on **0508 800 800**.

Please indicate which rule of the One Plan your activity falls under Refer to Assessment of Environmental Effects

The 'Land and Freshwater' (RP-LF-AWBD) chapter can be accessed via http://www.horizons.govt.nz/publications-feedback/one-plan/part-2-regional-plan/chapter-17

5 ASSESSMENT OF ENVIRONMENTAL EFFECTS

For your application to be considered, an assessment of effects must be included. Please answer all questions below. Additional information may need to be provided depending on the scale and significance of your proposal.

Considering the Surface Water Management Area your proposed activity is in, are there any RP-SCHED2 values identified for this reach of the river? ☑ Yes ☐ No

You can access this information via http://www.horizons.govt.nz/publications-feedback/one-plan/part-3-annexes/schedules

If 'Yes', please identify what values these are and describe how you intend to avoid, remedy or mitigate adverse effects of the proposed structure on each of these values?

(E.g. trout spawning – avoid work between 1 May to 30 September (inclusive)

Refer to Assessment of Environmental Effects

Please note that depending on the values identified and the method of carrying out the proposed activity, a separate ecological assessment may be required by a suitable qualified independent ecologist, experienced in river ecological management.

Describe the actual and potential effects that the proposed activity could have on the environment.

Effects during construction *(e.g. disturbance of stream bed, sediment release, immediate vicinity)*. Please also comment if/how the water will be diverted during construction, including the duration, method, and effects of this.

Refer to Assessment of Environmental Effects

Effects of the completed works or structure on the riverbed, both upstream and downstream, both in typical and extreme conditions *(e.g. flooding upstream and/or downstream, ongoing erosion).* Please provide an assessment and any supporting calculations. You will need to ensure you comment on where the water will go if the structure fails/blocks/collapses.

Refer to Assessment of Environmental Effects

Effects on water quality *(e.g. sedimentation effects).*

Refer to Assessment of Environmental Effects

Effects on fish passage and habitat *(e.g. perched culverts),* **and proposed measures to avoid them** *(e.g. burying culvert invert below streambed, fish ladders).*

Refer to Assessment of Environmental Effects

Any other effects *(including cultural). If your proposed activity falls under a Discretionary or Non-Complying Activity status, an assessment of cultural effects will be required. This should be informed by [written] feedback from the relevant iwi and/or hapū. For indicative rohe and contact details of your local iwi and/or hapū please visit http://www.tkm.govt.nz/.*

Refer to Assessment of Environmental Effects

6 EFFECT ON STATUTORY ACKNOWLEDGMENTS

Is the activity on, adjacent to, or may affect land that is subject of a statutory acknowledgment? ☐ Yes ☑ No

List of statutory acknowledgments:
Ngāti Tūwharetoa (Bay of Plenty) Claims Settlement Act 2005
Ngaa Rauru Kiitahi Claims Settlement Act 2005
Ngāti Apa (North Island) Claims Settlement Act 2010
Rangitāne o Manawatu Claims Settlement Act 2016
Rangitāne Tū Mai Rā (Wairarapa Tamaki nui-ā-Rua) Claims Settlement Act 2017
Ngāti Rangi Claims Settlement Act 2019

Information on statutory acknowledgments can be found on the Horizons website: **https://www.horizons.govt.nz/about-our-region-and-council/iwi-and-hapu**

If yes, Council must have regard to the statutory acknowledgments. We recommend that applicants considering undertaking works that may affect a statutory acknowledgment make contact with local iwi and/or hapū before the lodgement of a consent application to determine if there are any effects on the statutory acknowledgment.

7 TE AWA TUPUA (WHANGANUI RIVER CLAIMS SETTLEMENT) ACT 2017

Are the proposed works in the Whanganui catchment? ☐ Yes ☑ No
Please note that this covers a large area. If you are unsure, please contact the consents team.

If yes, the Whanganui River and its wider catchment is the subject of the Te Awa Tupua (Whanganui River Claims Settlement) Act 2017. Council must have regard to the values of Te Awa Tupua when making a decision on any application we receive (regardless of activity status). On that basis, we recommend that parties considering undertaking works within the Whanganui catchment make contact with Ngā Tāngata Tiaki o Whanganui and local iwi and/or hapū before lodgement of a consent application to confirm any requirements under Te Awa Tupua and obtain feedback on the proposed works.

8 TE WAIŪ-O-TE-IKA - WHANGAEHU RIVER (NGĀTI RANGI CLAIMS SETTLEMENT ACT 2019)

Are the proposed works in the Whanganui catchment? ☐ Yes ☑ No
Please note that this covers a large area. If you are unsure, please contact the consents team.

If yes, the Whangaehu River and its wider catchment is the subject of Te Waiū-o-Te-Ika (Ngāti Rangi Claims Settlement Act 2019). Council must have regard to the values (Te Mana Tupua and Ngā Toka Tupua) of Te Waiū-o-Te-Ika when making a decision on any application we receive (regardless of activity status). On that basis, we recommend that parties considering undertaking works within the Whangaehu catchment make contact with local iwi and/or hapū before lodgement of a consent application to confirm any requirements under Te Waiū-o-Te-Ika and obtain feedback on the proposed works.

9 GOOD MANAGEMENT PRACTICES AND MITIGATION MEASURES

Please include a description of the monitoring or good management practices to be undertaken to help avoid, reduce, remedy or mitigate the actual and potential effects on the environment.

What methods or actions will be used to reduce or prevent any identified environmental effects and stabilise the exposed earth?
You may need to refer to the "Erosion and Sediment Control Guidelines for the Wellington Region" (February 2021) for further information.

Refer to Assessment of Environmental Effects

Please describe how you will minimise the release of silt, sediment and other contaminant into water.
Please provide an erosion and sediment control plan if applicable.

Refer to Assessment of Environmental Effects

Do you have a flood contingency plan? ☐ Yes ☐ No
If 'Yes', please provide this plan with the application.

What methods or actions will be used to reduce or prevent any identified environmental effects after construction?
(e.g. grassing and planting of fill batters, metalling of approaches, stabilisation of abutments by gabion baskets)

Refer to Assessment of Environmental Effects

What, if any, monitoring do you propose to carry out?

Refer to Assessment of Environmental Effects

10 CONSIDERATION OF ALTERNATIVES

Describe any alternative options considered, and reasons why these are not proposed.

Refer to Assessment of Environmental Effects

11 CONSULTATION/AFFECTED PARTIES

Please include evidence of any consultation undertaken for this application. This may include (but not be limited to) consultation with adjoining landowners, other consent holders in the immediate area, Iwi, government departments/ministries (e.g. DOC), territorial authorities and recreational associations (e.g. Fish and Game New Zealand). Please ensure that you have considered any statutory acknowledgements in the Horizons Region. For more information visit *(http://www.horizons.govt.nz/about-our-region-and-council/iwi-and-hapu/statutory-acknowledgements)*

If you are in doubt about who you should be talking to call a member of the consents team on **0508 800 800.**

Please provide details of those you have identified as parties who may be affected. If you have discussed your proposal with any of these parties, please record any comments made by them and your response to them, and submit this with your application.

Name Refer to Assessment of Environmental Effects

Address .....

.....

☐ Affected party approval form attached

Name .....

Address .....

.....

☐ Affected party approval form attached

Name .....

Address .....

.....

☐ Affected party approval form attached

Name .....

Address .....

.....

☐ Affected party approval form attached

12 NATIONAL ENVIRONMENTAL STANDARDS

NATIONAL ENVIRONMENTAL STANDARDS FOR SOURCES OF HUMAN DRINKING WATER (NES-HDW)

Are there any public water supplies that could be affected by your proposal? ☑ Yes ☐ No

An assessment under the NES-HDW will need to identify any sources of human drinking water that supply more than 25 people that might be affected by the discharge. Horizons Regional Council holds a list of such water supplies within its region and will be able to provide assistance when identifying water supplies within the vicinity of the activity.

Discussion with the water supply operator may also be beneficial in determining whether the supply could be affected and what measures can be taken to ensure the quality of the water supply is maintained.

Refer to Assessment of Environmental Effects.

Note: Public water supply 'affected' is the same as the activity for which consent is sought.

Please state any other NES that you consider may be relevant to your activity and provide an assessment against that NES.

Refer to Assessment of Environmental Effects

13 RELEVANT STATUTORY PROVISIONS

The Resource Management Act 1991 requires this application to include an assessment of the proposed activity against the One Plan. Answering the following questions will satisfy this requirement. If you are unable to answer the questions below, or you believe your proposal is inconsistent with the relevant policies and documents discussed, it is recommended you seek professional planning assistance to help you with your application.

For a complete copy of the One Plan visit http://www.horizons.govt.nz/publications-feedback/one-plan

REGIONAL POLICY ASSESSMENT

The objectives and policies of the 'Resource Management Issues of Significance to Hapu and Iwi' (RPS-RMIA) chapter and the 'Land and Freshwater' (RPS-LF-FW) chapter are relevant to this application.

Is the activity consistent with the relevant provisions of the Regional Policy Statement? ☑ Yes ☐ No

Please provide reasons for your answer above

Refer to Assessment of Environmental Effects

Please list any other relevant objectives and/or policies of the Regional Policy Statement and provide an assessment of the activity against those objectives and/or policies.

Refer to Assessment of Environmental Effects

REGIONAL PLAN ASSESSMENT

Objective LF-AWBD-O5 and Policies LF-AWBD-P22 and LF-AWBD-P23 of the 'Land and Freshwater' (RP-LF-AWBD) chapter of the Regional Plan may be relevant to this application.

Is the activity consistent with the relevant provisions of the Regional Plan? ☐ Yes ☐ No

Please provide reasons for your answer above

Refer to Assessment of Environmental Effects

If there are other sections of the One Plan or any national planning document (e.g. NZ Coastal Policy Statement) that you consider are relevant, please provide an assessment of the activity against those relevant objectives/policies of the One Plan and/or national document.

Refer to Assessment of Environmental Effects

14 ADDITIONAL INFORMATION CHECKLIST

- [x] Completed administration form (Form A).
- [x] A SITE plan to scale showing:
  - Surrounding key roads, towns etc. for orientation
  - The location of the proposed works
  - The location of any river crossing access points
  - Any structures within 500 metres upstream and downstream of the extraction point/s
  - Any other relevant features
- [ ] Colour photographs of the proposed activity location, looking 50 metres upstream and 50 metres downstream of the proposed site.
- [ ] Erosion and sediment control plan (if applicable)
- [ ] Flood contingency plan (if applicable)
- [ ] Affected party approval form/s

Please contact the consents team on freephone **0508 800 800** if you require assistance with your application.

Application for
Resource Consent: Vegetation Clearance or Disturbance

horizons REGIONAL COUNCIL

Form B: Activity Information and Assessment Form

A complete Administration Form (Form A) MUST accompany this Activity Information and Assessment Form (Form B) when lodging your application. The purpose of this form is to provide the applicant with guidance on information that is required under the Resource Management Act 1991. These forms are to act as a guide only, and Horizons Regional Council reserves the right to request additional information.

APPLICANT NAME Horowhenua District Council
(Refer to Form A)

1 APPLICATION PURPOSE

What is the purpose of this application (select one)

- ○ Activities related to a plantation forest* (as defined in section 3 of the National Environmental Standard for Commercial Forestry)
- ○ Activities within a
  - ☐ At-Risk Habitat**
  - ☐ Rare Habitat**
  - ☐ Threatened Habitat**
- ◉ Other

**If the area of vegetation clearance is vegetation which has been planted specifically as a production forest please check that it is not an activity made permissible by the National Environmental Standard for Commercial Forestry (NES-CF). There is a form available on our website for notification of permitted activities under the NES-CF.*

***Further information on rare, threatened or at-risk habitats can also be found in RP-SCHED6 of the One Plan (https://www.horizons.govt.nz/publications-feedback/one-plan/one-plan-as-amended-by-plan-ammendment-1)*

Please note some district and city councils require additional earthwork and/or vegetation clearance consents. Please make sure you contact the relevant council to ensure this is not the case.

Consent term sought 35 years
(Max. 35 years)

Resource consents are typically aligned with the relevant common catchment expiry dates in Policy IP-P5 of the One Plan.

2 LOCATION

Location of the proposed vegetation or disturbance Refer to Assessment of Environmental Effects

Address .....

.....

Map reference (NZTM 2000) E Refer to Assessment of Environmental Effects N Refer to Assessment of Environmental Effects

Legal description Refer to Assessment of Environmental Effects

A detailed site map will be required with this application.

Does the forest, block or woodlot have a common name, if so what is it?

N/A

3 DESCRIPTION OF PROPOSED ACTIVITY

Please describe the vegetation type proposed to be cleared and the reason for the vegetation clearance.

Refer to Assessment of Environmental Effects

Please describe the contour of the land at and surrounding the site. Please also indicate the percentage of the site that the contour type covers.

Flat ..... % Refer to Assessment of Environmental Effects

Rolling ..... %

Steep ..... %

Very steep (over 20 degrees/hill country erosion management area) ..... %

Predominant soil type

- ☐ Sand
- ☐ Loam
- ☐ Pumice
- ☐ Silt
- ☐ Clay
- ☐ Peat
- ☐ Other *(please specify)* .....

Refer to Assessment of Environmental Effects

Describe the extent of any soil erosion present on the site.

Refer to Assessment of Environmental Effects

Are there any waterways (including drains), wetlands or lakes near the land disturbance site and how far away are they?

Please note this includes both artificial waterways, permanently flowing and intermittently flowing waterways.

Refer to Assessment of Environmental Effects

What is the total area in m^2 which will be removed or disturbed?

Refer to Assessment of Environmental Effects

What time of year do you intend to undertake the works?

Refer to Assessment of Environmental Effects

How long will the works take to complete? *(if the work is being undertaken in stages please describe these).*

Refer to Assessment of Environmental Effects

Will the site be revegetated? ☐ Yes ☐ No

If 'Yes' please describe what will be planted and when.

Refer to Assessment of Environmental Effects

Please detail the methods for harvesting and/or removal.

Refer to Assessment of Environmental Effects

4 RULE ASSESSMENT

The National Environmental Standard for Commercial Forestry (NES-CF) permits a number of forestry activities including harvesting activities. Additionally the rules in the One Plan permits vegetation clearance so long as it meets Rule LF-LAND-R5, including the relevant conditions and standards.

Please ensure your activity is not a permitted activity under these regulations or rule/s. If you require assistance, please contact the consents team at Horizons on freephone 0508 800 800.

Please indicate which rule of the One Plan or relevant regulation your activity falls under

Refer to Assessment of Environmental Effects

Chapters RP-LF-LAND can be accessed at https://www.horizons.govt.nz/publications-feedback/one-plan/one-plan-as-amended-by-plan-ammendment-1
The NES-CF can be viewed at https://www.mpi.govt.nz/forestry/national-environmental-standards-commercial-forestry/

5 ASSESSMENT OF ENVIRONMENTAL EFFECTS

For your application to be considered, an assessment of environmental effects must be included. Please answer all questions below. Additional information may need to be provided depending on the scale and significance of your proposal.

If the proposed activity is in a rare habitat*, threatened habitat* or at-risk habitat* your application is either a discretionary activity or a non-complying activity and a full assessment of environmental effects, prepared by a suitably qualified person must accompany your application, appropriate to the scale of the non-compliance with the rules above.

Please provide details of what vegetation will be removed (species, maturity and quantity) and if the clearance is selective or contiguous.

Refer to Assessment of Environmental Effects

Please provide details of how the vegetation will be disturbed and/or removed (eg. spraying, mechanical harvesting).

Refer to Assessment of Environmental Effects

Detail any hazardous or toxic chemicals or hydrocarbons (such as fuel) that are related to your activity and may be used or stored on site or used as part of the operation. Describe how these will be managed to avoid risk to the environment. If vegetation clearance is by way of spraying please include a spray plan written in accordance the NZS8409:2004 Management of Agrichemicals.

Refer to Assessment of Environmental Effects

Describe any effects your operation may have on the neighbourhood including dust, sedimentation of waterways, land stability and cultural effects. Other areas that need effects assessed are historic sites and recreational areas, such as parks, scientific areas, and scenic features. *If your proposed activity falls under a Discretionary or Non-Complying Activity status, an assessment of cultural effects will be required. This should be informed by [written] feedback from the relevant iwi and/or hapū. For indicative rohe and contact details of your local iwi and/or hapū please visit http://www.tkm.govt.nz/.*

Refer to Assessment of Environmental Effects

Does the proposed activity involve vegetation clearance in a rare habitat, threatened habitat or at-risk habitat as defined in RP-SCHED6 of the One Plan? ☐ Yes ☐ No

Refer to Assessment of Environmental Effects

If 'Yes', please confirm this form is accompanied by a full assessment of environmental effects, prepared by a suitably qualified person, appropriate to the scale of the non-compliance with the rules above.

☐ Yes *An assessment of environmental effects is attached*

☐ No *Please provide a reason why*

Refer to Assessment of Environmental Effects

6 EFFECT ON STATUTORY ACKNOWLEDGMENTS

Is the activity on, adjacent to, or may affect land that is subject of a statutory acknowledgment? ☐ Yes ☑ No

List of statutory acknowledgments:
Ngāti Tūwharetoa (Bay of Plenty) Claims Settlement Act 2005
Ngaa Rauru Kiitahi Claims Settlement Act 2005
Ngāti Apa (North Island) Claims Settlement Act 2010
Rangitāne o Manawatu Claims Settlement Act 2016
Rangitāne Tū Mai Rā (Wairarapa Tamaki nui-ā-Rua) Claims Settlement Act 2017
Ngāti Rangi Claims Settlement Act 2019

Information on statutory acknowledgments can be found on the Horizons website: **https://www.horizons.govt.nz/about-our-region-and-council/iwi-and-hapu**

If yes, Council must have regard to the statutory acknowledgments. We recommend that applicants considering undertaking works that may affect a statutory acknowledgment make contact with local iwi and/or hapū before the lodgement of a consent application to determine if there are any effects on the statutory acknowledgment.

7 TE AWA TUPUA (WHANGANUI RIVER CLAIMS SETTLEMENT) ACT 2017

Are the proposed works in the Whanganui catchment? ☐ Yes ☑ No
Please note that this covers a large area. If you are unsure, please contact the consents team.

If yes, the Whanganui River and its wider catchment is the subject of the Te Awa Tupua (Whanganui River Claims Settlement) Act 2017. Council must have regard to the values of Te Awa Tupua when making a decision on any application we receive (regardless of activity status). On that basis, we recommend that parties considering undertaking works within the Whanganui catchment make contact with Ngā Tāngata Tiaki o Whanganui and local iwi and/or hapū before lodgement of a consent application to confirm any requirements under Te Awa Tupua and obtain feedback on the proposed works.

8 TE WAIŪ-O-TE-IKA - WHANGAEHU RIVER (NGĀTI RANGI CLAIMS SETTLEMENT ACT 2019)

Are the proposed works in the Whanganui catchment? ☐ Yes ☑ No
Please note that this covers a large area. If you are unsure, please contact the consents team.

If yes, the Whangaehu River and its wider catchment is the subject of Te Waiū-o-Te-Ika (Ngāti Rangi Claims Settlement Act 2019). Council must have regard to the values (Te Mana Tupua and Ngā Toka Tupua) of Te Waiū-o-Te-Ika when making a decision on any application we receive (regardless of activity status). On that basis, we recommend that parties considering undertaking works within the Whangaehu catchment make contact with local iwi and/or hapū before lodgement of a consent application to confirm any requirements under Te Waiū-o-Te-Ika and obtain feedback on the proposed works.

9 GOOD MANAGEMENT PRACTICES AND MITIGATION MEASURES

As part of managing on-site sediment effects we need to assess what mitigation measures are proposed.

For forestry harvesting under the NES-CF this needs to be a forestry earthworks management plan in accordance with Schedule 4 of the NES-CF.

For all other vegetation clearance please supply an Erosion and Sediment Control Plan which is written in accordance with Section 8 of the "Erosion and Sediment Control Guidelines for the Wellington Region" dated September 2002 (or any superseding guidelines). This document can be sourced from www.gw.govt.nz.

An Erosion and Sediment Control Plan normally contains two parts, a written methodology and a site plan. The written methodology contain information on various aspects of the project and proposed erosion and sediment controls including how sediment loss will be minimised. The site plan provides a visual understanding of what the site looks like and includes details such as the location of erosion and sediment control devices and other relevant features.

Please confirm a forestry earthworks management plan or an Erosion and Sediment Control Plan is attached.

☐ Yes *Forestry earthworks management plan written in accordance with the NES-CF is attached*

☐ Yes *Erosion and sediment control plan attached*

☐ No *Please detail why*

What, if any, monitoring do you propose to carry out to avoid, remedy, mitigate the potential adverse environmental effects of the proposal?

Refer to Assessment of Environmental Effects

In a large operation, regular compliance tests may be required to be undertaken for any discharges such as those from sediment retention ponds. How do you plan to monitor the discharges?

Refer to Assessment of Environmental Effects

How will you contain and manage slash?

Refer to Assessment of Environmental Effects

10 CONSIDERATION OF ALTERNATIVES

Please include a description of any possible alternative locations or methods for undertaking the any discharges associated with the works (*E.g. discharge of sediment from the harvesting site, management of slash*) and why these alternatives have not been selected.

Refer to Assessment of Environmental Effects

11 CONSULTATION/AFFECTED PARTIES

Please include evidence of any consultation undertaken for this application. This may include (but not be limited to) consultation with adjoining landowners, other consent holders in the immediate area, Iwi, government departments/ministries (e.g. DOC), territorial authorities and recreational associations (e.g. Fish and Game New Zealand).
If you are in doubt about who you should be talking to the call a member of the consents team on freephone **0508 800 800**.

Please provide details of those you have identified as parties who may be affected. If you have discussed your proposal with any of these parties, please record any comments made by them and your response to them and submit this with your application.

Name Refer to Assessment of Environmental Effects

Address .....

.....

☐ Affected party approval form attached

Name .....

Address .....

.....

☐ Affected party approval form attached

Name .....

Address .....

.....

☐ Affected party approval form attached

Name .....

Address .....

.....

☐ Affected party approval form attached

12 NATIONAL ENVIRONMENTAL STANDARDS

NATIONAL ENVIRONMENTAL STANDARDS FOR SOURCES OF HUMAN DRINKING WATER (NES-HDW)

Are there any public water supplies that could be affected by your proposal? ☑ Yes ☐ No

An assessment under the NES-HDW will need to identify any sources of human drinking water that supply more than 25 people that might be affected by any discharge. Horizons Regional Council holds a list of such water supplies within its region and will be able to provide assistance when identifying water supplies within the vicinity of the farming activity.

Discussion with the water supply operator may also be beneficial in determining whether the supply could be affected and what measures can be taken to ensure the quality of the water supply is maintained.

Refer to Assessment of Environmental Effects.

Note: Public water supply 'affected' is the same as the activity for which consent is sought.

NEW ZEALAND COASTAL POLICY STATEMENT (NZ-CPS)

This document is only relevant if your activity is within or adjacent to the coastal marine area. If applicable, an assessment is required against the NZ-CPS.

N/A

13 RELEVANT STATUTORY PROVISIONS

The Resource Management Act 1991 requires this application to include an assessment of the proposed activity against the One Plan. Answering the following questions will satisfy this requirement. If you are unable to answer the questions below, or you believe your proposal is inconsistent with the relevant policies and documents discussed, it is recommended you seek professional planning assistance to help you with your application. For a complete copy of the One Plan visit *http://www.horizons.govt.nz/publications-feedback/one-plan.*

REGIONAL POLICY ASSESSMENT

The objectives and policies of the 'Land and Freshwater' (RPS-LAND and RPS-FW) chapters and the 'Ecosystems and Indigenous Biodiversity' (RPS-ECO) chapter are relevant to this application.

Is the activity consistent with the relevant provisions of the Regional Policy Statement? ☑ Yes ☐ No

Please provide reasons for your answer above

Refer to Assessment of Environmental Effects

Please list any other relevant objectives and/or policies of the Regional Policy Statement and provide an assessment of the activity against those objectives and/or policies.

Refer to Assessment of Environmental Effects

REGIONAL PLAN ASSESSMENT

Objective LF-LAND-01 and Policies LF-LAND-P1 and LF-LAND-P2 of the 'Land and Freshwater' (RPS-LF-FW) chapter of the Regional Plan are relevant to this application.

Is the activity consistent with the relevant provisions of the Regional Plan? ☑ Yes ☐ No

Please provide reasons for your answer above

Refer to Assessment of Environmental Effects

If there are other section of the One Plan or any national planning document (e.g. NZ Coastal Policy Statement) that you consider relevant, please provide an assessment of the activity against those relevant objectives/policies of the One Plan and/or national document.

Refer to Assessment of Environmental Effects

14 ADDITIONAL INFORMATION REQUIRED WITH THIS FORM

☑ Administration Form (Form A)

☑ A SITE plan to scale showing

- Site boundary
- Location of roads and property boundaries
- Buildings and residential properties
- Location of any sensitive sites (e.g. historical places, sites of importance to iwi) in the proximity of the site
- Location of any waterways including ephemeral waterways, drains, lakes, wetlands

☐ If undertaking spraying of vegetation a spray plan written in accordance with the NZS8409:2004 Management of Agrichemicals

☐ An erosion and sediment control plan or forestry earthworks management plan, appropriate to the scale of the works.

☐ For vegetation clearance within at-risk, rare or threatened habitats a full assessment of environmental effects prepared by a suitably qualified person, appropriate to the scale of the non-compliance with the rule consent is being sought under.

Please contact the consents team on freephone **0508 800 800** if you require assistance with your application.

Application for **Resource Consent: Land Disturbance (Earthworks) and/or Cleanfill**

horizons REGIONAL COUNCIL

Form B: Activity Information and Assessment Form

A complete Administration Form (Form A) MUST accompany this Activity Information and Assessment Form (Form B) when lodging your application. The purpose of this form is to provide the applicant with guidance on information that is required under the Resource Management Act 1991. These forms are to act as a guide only, and Horizons Regional Council reserves the right to request additional information.

APPLICANT NAME Horowhenua District Council
(Full Legal Name of all Applicants - should match what is on Form A)

1 APPLICATION PURPOSE

What is the purpose of this application (select one)

- (●) New consent
- ( ) Renewal of consent
  Consent number ..... Expiry date.....

Consent term sought 35 years
(Max. 35 years)

Resource consents are typically aligned with the relevant common catchment expiry dates in Policy IP-P5 of the One Plan.

What is the reason for the proposed land disturbance? *(E.g. subdivision, quarry)*

Construction of water storage reservoir

Please specify the type of works which occur *(please tick)*

- [ ] Soil disturbance and/or roading and tracking
- [ ] Cleanfill placement – natural material such as clay, soil and rock and other inert materials such as concrete or brick
- [ ] Overburden placement – clay, soil and rock associated with quarries and mining
- [x] Earthworks associated with a structure
- [ ] Quarry
- [ ] Other – specify in more detail below

Please note some district and city councils require additional earthworks consents. Please make sure you contact the relevant council to ensure this is not the case.

2 LOCATION

Location of the proposed works. Poads Road, Levin

Address Refer to Assessment of Environmental Effects

Map reference (NZTM 2000) E ..... N .....

Legal description. Lot 9 DP555714

3 DESCRIPTION OF PROPOSED ACTIVITY

Please describe the present land use of the site *(please tick)*

- [x] Farming (beef, dairy, sheep etc)
- [ ] Reserve (conservation, recreational, marginal strip)
- [ ] Exotic forest native forest/regenerating bush/rare, threatened or at-risk site*
- [ ] Other – please specify .....

**As defined in RP-SCHED6 of the One Plan*

Please describe the contour of the land at and surrounding the site. Please also indicate the percentage of the site that the contour type covers.

Flat ..... %

Rolling ..... %

Steep ..... %

Very steep (over 20 degrees/hill country erosion management area) ..... %

Predominant soil type *(please tick)*

- [ ] Sand
- [ ] Loam
- [ ] Pumice
- [ ] Silt
- [ ] Clay
- [ ] Peat
- [ ] Other – *(please specify)* .....

Describe the extent of any soil erosion

Please note this includes both artificial waterways and permanently flowing and intermittently flowing waterways with a bed greater than 1m.

What is the total area in m^2 which will be disturbed?

What is the total volume of material that will be disturbed, or for a clean fill site, disposed of?

For earthworks, where will you dispose of the cleared material?

Refer to Assessment of Environmental Effects for all relevant details

What time of year do you intend to do the works?

How long will the works take to complete? *(If the work is being undertaken in stages please describe these).*

What type of vegetation currently covers the site?

Will the site be revegetated? Please describe what will be planted.

For cleanfill sites, where will the material be imported from?

4 RULE ASSESSMENT

Rule LF-LAND-R1 of the One Plan permits earthwork activities and Rule LF-LW-R29 of the One Plan permits certain cleanfill activities as long as you can meet certain conditions and standards. Please ensure your activity is not a permitted activity under these rule(s). If you require assistance, please contact the consents team on freephone 0508 800 800.

Please indicate which rule of the One Plan your activity falls under Refer to Assessment of Environmental Effects

The 'Land use activities' (LAND) and 'Discharges to land and water' (LW) sections of the 'Land and Freshwater' (RP-LF) chapter can be accessed via http://www.horizons.govt.nz/publications-feedback/one-plan.

5 ASSESSMENT OF ENVIRONMENTAL EFFECTS

For your application to be considered, an assessment of effects must be included. Please answer all questions below. Additional information may need to be provided depending on the scale and significance of your proposal.

Detail any hazardous or toxic chemicals or hydrocarbons (such as fuel) that are related to your activity and may be used or stored on site. Describe how these will be managed to avoid risk to the environment.

Refer to Assessment of Environmental Effects

Describe any effects your operation may have on the neighbourhood, including dust, sedimentation of waterways, land stability and cultural effects. Other areas that need effects assessed are historic sites and recreational areas, such as parks, scientific areas, and scenic features.

Refer to Assessment of Environmental Effects

If your proposed activity falls within a Discretionary or Non-Complying Activity status, please note that an assessment of cultural effects will be required. This should be informed by [written] feedback from the relevant iwi and/or hapū. For indicative rohe and contact details of your local iwi and/or hapū please visit http://www.tkm.govt.nz/.

6 EFFECT ON STATUTORY ACKNOWLEDGMENTS

Is the activity on, adjacent to, or may affect land that is subject of a statutory acknowledgment? ☐ Yes ☑ No

List of statutory acknowledgments:
Ngāti Tūwharetoa (Bay of Plenty) Claims Settlement Act 2005
Ngaa Rauru Kiitahi Claims Settlement Act 2005
Ngāti Apa (North Island) Claims Settlement Act 2010
Rangitāne o Manawatu Claims Settlement Act 2016
Rangitāne Tū Mai Rā (Wairarapa Tamaki nui-ā-Rua) Claims Settlement Act 2017
Ngāti Rangi Claims Settlement Act 2019

Information on statutory acknowledgments can be found on the Horizons website: **https://www.horizons.govt.nz/about-our-region-and-council/iwi-and-hapu**

If yes, Council must have regard to the statutory acknowledgments. We recommend that applicants considering undertaking works that may affect a statutory acknowledgment make contact with local iwi and/or hapū before the lodgement of a consent application to determine if there are any effects on the statutory acknowledgment.

6 TE AWA TUPUA (WHANGANUI RIVER CLAIMS SETTLEMENT) ACT 2017

Are the proposed works in the Whanganui catchment? ◯ Yes ◉ No
Please note that this covers a large area. If you are unsure, please contact the consents team.

If yes, the Whanganui River and its wider catchment is the subject of the Te Awa Tupua (Whanganui River Claims Settlement) Act 2017. Council must have regard to the values of Te Awa Tupua when making a decision on any application we receive (regardless of activity status). On that basis, we recommend that parties considering undertaking works within the Whanganui catchment make contact with Ngā Tāngata Tiaki o Whanganui and local iwi and/or hapū before lodgement of a consent application to confirm any requirements under Te Awa Tupua and obtain feedback on the proposed works.

7 TE WAIŪ-O-TE-IKA - WHANGAEHU RIVER (NGĀTI RANGI CLAIMS SETTLEMENT ACT 2019)

Are the proposed works in the Whangaehu catchment? ◯ Yes ◉ No
Please note that this covers a large area. If you are unsure, please contact the consents team.

If yes, the Whangaehu River and its wider catchment is the subject of Te Waiū-o-Te-Ika (Ngāti Rangi Claims Settlement Act 2019). Council must have regard to the values (Te Mana Tupua and Ngā Toka Tupua) of Te Waiū-o-Te-Ika when making a decision on any application we receive (regardless of activity status). On that basis, we recommend that parties considering undertaking works within the Whangaehu catchment make contact with local iwi and/or hapū before lodgement of a consent application to confirm any requirements under Te Waiū-o-Te-Ika and obtain feedback on the proposed works.

8

GOOD MANAGEMENT PRACTICES AND MITIGATION MEASURES

Please supply an Erosion and Sediment Control Plan appropriate to the scale of the works. The method and or management tools contained within the plan shall be, at a minimum, in general accordance with Section 8 of the "Erosion and Sediment Control Guidelines for the Wellington Region" dated September 2002 (or any later amendments). This document can be sourced from www.gw.govt.nz.

An Erosion and Sediment Control Plan normally contains two parts, a written methodology and a site plan. The written methodology contains information on various aspects of the project and proposed erosion and sediment controls including how sediment loss will be minimised. The site plan provides a visual understanding of what the site looks like and includes details such as the location of erosion and sediment control devices and other relevant features.

Please confirm an Erosion and Sediment Control Plan is attached ◉ Yes ○ No

What, if any, monitoring do you propose to carry out to avoid, remedy, mitigate the potential adverse environmental effects of the proposal?

Refer to Assessment of Environmental Effects

In a large operation, regular compliance tests may be required to be undertaken for any discharges such as those from sediment retention ponds. How do you plan to monitor the discharges?

Refer to Assessment of Environmental Effects

For cleanfill operations you must ensure there is a record of material in accordance with the "A Guide to the Management of Cleanfills (Ministry for the Environment, 2002)". Please advise how you will meet these requirements?

N/A

9 CONSIDERATION OF ALTERNATIVES

Please include a description of any possible alternative locations or methods for undertaking any discharges associated with the works *(E.g. discharge of sediment from earthworks site or location of cleanfill site)* and why these alternatives have not been selected.

Refer to Assessment of Environmental Effects

10 CONSULTATION/AFFECTED PARTIES

Please include evidence of any consultation undertaken for this application. This may include (but not be limited to) consultation with adjoining landowners, other consent holders in the immediate area, iwi, government departments/ministries (e.g. DOC), territorial authorities and recreational associations (E.g. Fish and Game New Zealand). Please ensure you have considered any Statutory Acknowledgements in the Horizons Region. For more information visit (http://www.horizons.govt.nz/about-our-region-and-council/iwi-and-hapu/statutory-acknowledgements). If you are in doubt about who you should be talking to the call a member of the consents team on freephone 0508 800 800.

Please provide details of those you have identified as parties who may be affected. If you have discussed your proposal with any of these parties, please record any comments made by them and your response to them and submit this with your application.

Name Refer to Assessment of Environmental Effects

Address .....

.....

☐ Affected party approval form attached

Name .....

Address .....

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☐ Affected party approval form attached

Name .....

Address .....

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☐ Affected party approval form attached

Name .....

Address .....

.....

☐ Affected party approval form attached

11 NATIONAL ENVIRONMENTAL STANDARDS

NATIONAL ENVIRONMENTAL STANDARDS FOR SOURCES OF HUMAN DRINKING WATER (NES-HDW)

Are there any public water supplies that could be affected by your proposal? (●) Yes ( ) No

An assessment under the NES-HDW will need to identify any sources of human drinking water that supply more than 25 people that might be affected by any discharge. Horizons Regional Council holds a list of such water supplies within its region and will be able to provide assistance when identifying water supplies within the vicinity of the farming activity.

Discussion with the water supply operator may also be beneficial in determining whether the supply could be affected and what measures can be taken to ensure the quality of the water supply is maintained.

Refer to Assessment of Environmental Effects.

Note: Public water supply 'affected' is the same as the activity for which consent is sought.

Please state any other NES that you consider may be relevant to your activity and provide an assessment against that NES.

NES-Freshwater.

Refer to attached Assessment of Environmental Effects. There is a small area affected which has a 'marginal' classification as a Natural Inland Wetland. Consent is sought under the NES-FW for earthworks within, and within 100m of, this area.

12 RELEVANT STATUTORY PROVISIONS

The Resource Management Act 1991 requires this application to include an assessment of the proposed activity against the One Plan. Answering the following questions will satisfy this requirement. If you are unable to answer the questions below, or you believe your proposal is inconsistent with the relevant policies and documents discussed, it is recommended you seek professional planning assistance to help you with your application. For a complete copy of the One Plan visit *http://www.horizons.govt.nz/publications-feedback/one-plan.*

REGIONAL POLICY ASSESSMENT

The objectives and policies of the 'Land' (LAND) and 'Freshwater' (FW) sections in the 'Land and Freshwater' (RPS-LF) chapter are relevant to this application.

Is the activity consistent with the relevant provisions of the Regional Policy Statement? (●) Yes ( ) No

Please provide reasons for your answer above

Refer to Assessment of Environmental Effects

Please list any other relevant objectives and /or policies of the Regional Policy Statement and provide an assessment of the activity against those objectives and/or policies.

Refer to Assessment of Environmental Effects

REGIONAL PLAN ASSESSMENT

Objective LF-LAND-O1 and Policy LF-LAND-P1 and LF-LAND-P2 of the 'Land and Freshwater' (LF-LAND) chapter of the Regional Plan are relevant to this application.

Is the activity consistent with the relevant provisions of the Regional Plan? (●) Yes ( ) No

Please provide reasons for your answer above

Refer to Assessment of Environmental Effects

If there are other sections of the One Plan or any national planning document (e.g. NZ Coastal Policy Statement) that you consider are relevant, please provide an assessment of the activity against those relevant objectives/policies of the One Plan and/or national document.

13 ADDITIONAL CHECKLIST INFORMATION

☑ A SITE plan to scale showing:

- Site boundary
- Location of roads and property boundaries
- Buildings and residential properties
- Location of any sensitive sites (e.g. historical places, sites of importance to iwi) in the proximity of the site
- Identification of any rare, threatened or at-risk habitats
- Any waterways including ephemeral waterways, drains, lakes and/or wetlands.

☑ An Erosion and Sediment Control Plan appropriate to the scale of the works.
The method and or management tools contained within the plan shall be in general accordance with Section 8 of the "Erosion and Sediment Control Guidelines for the Wellington Region" dated September 2002.

Please contact the consents team on freephone **0508 800 800** if you require assistance with your application.

Application for
Resource Consent: Discharge to Land (General)

Form B: Activity Information and Assessment Form

horizons REGIONAL COUNCIL

A complete Administration Form (Form A) MUST accompany this Activity Information and Assessment Form (Form B) when lodging your application. The purpose of this form is to provide the applicant with guidance on information that is required under the Resource Management Act 1991. These forms are to act as a guide only, and Horizons Regional Council reserves the right to request additional information.

APPLICANT NAME Horowhenua District Council
(Refer to Form A)

1 APPLICATION PURPOSE

What is the purpose of this application (select one)

☑ New consent

☐ Renewal of consent

Consent number ..... Expiry date .....

Consent term sought 35 years
(Max. 35 years)

Note: Resource consents are typically aligned with the relevant common catchment expiry dates in Policy IP-P5 of the One Plan.

2 LOCATION AND SITE DESCRIPTION

Location of the proposed discharge Refer to Assessment of Environmental Effects

Address Refer to Assessment of Environmental Effects

Map reference (NZTM 2000) E Refer to Assessment of Environmental Effects N Refer to Assessment of Environmental Effects

Legal description Refer to Assessment of Environmental Effects

A detailed site map will be required with this application.

Refer to Assessment of Environmental Effects

Describe the type of land use surrounding the site *(e.g. north, residential – closest 500m; south, industrial, etc)* and identify any sensitive receiving environments.

Refer to Assessment of Environmental Effects

3 DESCRIPTION OF PROPOSED ACTIVITY

What is the source of the contaminant/s? (*E.g. industry, cleanfill, landfill composting animal wastes, breweries etc.)*

Refer to Assessment of Environmental Effects

Provide a detailed description of contaminant characteristics, physical and chemical composition, and whether it is a classified hazardous substance.

Refer to Assessment of Environmental Effects

Is the waste treated before being discharged? ☐ **YES** ☑ **NO** N/A discharge is groundwater to land.

If 'Yes', please describe the treatment.

Describe the discharge method, period, volume and rate of discharge *(include calculations)*.

Refer to Assessment of Environmental Effects

Please provide any other information regarding the discharge to land that you consider may be relevant to this application.

Refer to Assessment of Environmental Effects

4 RULE ASSESSMENT

A number of the activities under the 'Land and Freshwater' (LF-LW) chapter of the One Plan are permitted activities as long as you can meet certain conditions and standards. Please ensure your activity is not a permitted activity under the 'Land and Freshwater' (LF-LW) chapter of the One Plan. If you require assistance, please contact the consents team on 0508 800 800.

Please indicate which rule of the One Plan your activity falls under Refer to Assessment of Environmental Effects

Chapter RP-LF-LW can be accessed via https://www.horizons.govt.nz/publications-feedback/one-plan/one-plan-as-amended-by-plan-ammendment-1

5 ASSESSMENT OF ENVIRONMENTAL EFFECTS

For your application to be considered, an assessment of effects must be included. Please answer all questions below. Additional information may need to be provided depending on the scale and significance of your proposal.

SOIL

Describe soil type/s in the discharge area/s and the source of this information. *(E.g. soil maps, soil test, local knowledge)*

Refer to Assessment of Environmental Effects

What effect will the discharge have on soil?

Refer to Assessment of Environmental Effects

GROUNDWATER

What is the depth to groundwater at the discharge site/s (and is the direction of groundwater flow known)?

Refer to Assessment of Environmental Effects

Are there any bores in the vicinity (including neighbouring properties), and what are they used for? ☐ **YES** ☑ **NO**

If 'Yes', please show them on the site plan and describe their use below.

What is the land drainage like in the discharge area/s? Is the soil artificially drained?

Refer to Assessment of Environmental Effects

What effect will the discharge have on groundwater?

Refer to Assessment of Environmental Effects

SURFACE WATER

How far is the nearest surface waterbody/s (including ephemeral) to the discharge area/s and in what direction *(E.g 50m north east)?*

Refer to Assessment of Environmental Effects

What effect will the discharge have on surface water?

Refer to Assessment of Environmental Effects

NEIGHBOURING PROPERTIES AND VEGETATION

Are there any sensitive environments close to the discharge area? ☑ **YES** ☐ **NO**

E.g. rare, threatened or at-risk habitats, recreational areas.

Refer to Assessment of Environmental Effects

If 'Yes', show them on the site plan and describe them below.

Refer to Assessment of Environmental Effects

Describe the potential effects that the proposed activity/operation could have on neighbouring properties and/or sensitive environments noted above. *If your proposed activity falls under a Discretionary or Non-Complying Activity status, an assessment of cultural effects will be required. This should be informed by [written] feedback from the relevant iwi and/or hapū. For indicative rohe and contact details of your local iwi and/or hapū please visit http://www.tkm.govt.nz/.*

Refer to Assessment of Environmental Effects

6 EFFECT ON STATUTORY ACKNOWLEDGMENTS

Is the activity on, adjacent to, or may affect land that is subject of a statutory acknowledgment? ☐ Yes ☑ No

List of statutory acknowledgments:
Ngāti Tūwharetoa (Bay of Plenty) Claims Settlement Act 2005
Ngaa Rauru Kiitahi Claims Settlement Act 2005
Ngāti Apa (North Island) Claims Settlement Act 2010
Rangitāne o Manawatu Claims Settlement Act 2016
Rangitāne Tū Mai Rā (Wairarapa Tamaki nui-ā-Rua) Claims Settlement Act 2017
Ngāti Rangi Claims Settlement Act 2019

Information on statutory acknowledgments can be found on the Horizons website: **https://www.horizons.govt.nz/about-our-region-and-council/iwi-and-hapu**

If yes, Council must have regard to the statutory acknowledgments. We recommend that applicants considering undertaking works that may affect a statutory acknowledgment make contact with local iwi and/or hapū before the lodgement of a consent application to determine if there are any effects on the statutory acknowledgment.

7 TE AWA TUPUA (WHANGANUI RIVER CLAIMS SETTLEMENT) ACT 2017

Are the proposed works in the Whanganui catchment? ☐ **YES** ☑ **NO**
Please note that this covers a large area. If you are unsure, please contact the consents team.

If yes, the Whanganui River and its wider catchment is the subject of the Te Awa Tupua (Whanganui River Claims Settlement) Act 2017. Council must have regard to the values of Te Awa Tupua when making a decision on any application we receive (regardless of activity status). On that basis, we recommend that parties considering undertaking works within the Whanganui catchment make contact with Ngā Tāngata Tiaki o Whanganui and local iwi and/or hapū before lodgement of a consent application to confirm any requirements under Te Awa Tupua and obtain feedback on the proposed works.

8 TE WAIŪ-O-TE-IKA - WHANGAEHU RIVER (NGĀTI RANGI CLAIMS SETTLEMENT ACT 2019)

Are the proposed works in the Whanganui catchment? ☐ **YES** ☑ **NO**
Please note that this covers a large area. If you are unsure, please contact the consents team.

If yes, the Whangaehu River and its wider catchment is the subject of Te Waiū-o-Te-Ika (Ngāti Rangi Claims Settlement Act 2019). Council must have regard to the values (Te Mana Tupua and Ngā Toka Tupua) of Te Waiū-o-Te-Ika when making a decision on any application we receive (regardless of activity status). On that basis, we recommend that parties considering undertaking works within the Whangaehu catchment make contact with local iwi and/or hapū before lodgement of a consent application to confirm any requirements under Te Waiū-o-Te-Ika and obtain feedback on the proposed works.

9 GOOD MANAGEMENT PRACTICES AND MITIGATION MEASURES

Please include a description of the monitoring or mitigation measures (including safeguards and contingency plans where relevant) to be undertaken to help avoid, reduce, remedy or mitigate the actual or potential effects on environmental features and values.

In your description please include the following:

(a) treatment of the contaminants prior to discharge;

(b) buffer distances from water bodies, sloping land, site boundaries;

(c) details of any storage to be provided to enable deferred irrigation;

(d) a description of the monitoring system to be used for checking and recording the quality and quantity of the discharge. Please include how and when the monitoring will occur, and by whom; and

(e) contingency planning – describe how the equipment controlling the discharge will be operated and maintained to prevent equipment failure, and what measures will be implemented to ensure that the effects of any malfunction are remedied.

Refer to Assessment of Environmental Effects

10 CONSIDERATION OF ALTERNATIVES

Please include a description of any possible alternative locations or methods for undertaking the activity and why these alternatives have not been selected.

Refer to Assessment of Environmental Effects

11 CONSULTATION/AFFECTED PARTIES

Please include evidence of any consultation undertaken for this application. This may include (but not be limited to) consultation with adjoining landowners, other consent holders in the immediate area, Iwi, government departments/ministries (e.g. DoC), territorial authorities and recreational associations (e.g. Fish and Game New Zealand). Please ensure that you have considered any statutory acknowledgements in the Horizons Region. For more information visit http://www.horizons.govt.nz/about-our-region-and-council/iwi-and-hapu/statutory-acknowledgements)

If you are in doubt about who you should be talking to call a member of the consents team on **0508 800 800**.

Please provide details of those you have identified as parties who may be affected. If you have discussed your proposal with any of these parties, please record any comments and your response to them and submit this with your application.

Name Refer to Assessment of Environmental Effects

Address .....

.....

☐ Affected party approval form attached

Name .....

Address .....

.....

☐ Affected party approval form attached

Name .....

Address .....

.....

☐ Affected party approval form attached

Name .....

Address .....

.....

☐ Affected party approval form attached

12 NATIONAL ENVIRONMENTAL STANDARDS

NATIONAL ENVIRONMENTAL STANDARDS FOR SOURCES OF HUMAN DRINKING WATER (NES-HDW)

Are there any public water supplies that could be affected by your proposal? ☑ **YES** ☐ **NO**

An assessment under the NES-HDW will need to identify any sources of human drinking water that supply more than 25 people that might be affected by the activity. Horizons Regional Council holds a list of such water supplies within its region and will be able to provide assistance when identifying water supplies within the vicinity of the activity.

Discussion with the water supply operator may also be beneficial in determining whether the supply could be affected and what measures can be taken to ensure the quality of the water supply is maintained.

Refer to Assessment of Environmental Effects.

Note: Public water supply 'affected' is the same activity for which consent is sought.

Please state any other NES that you consider may be relevant to your activity and provide an assessment against that NES.

Refer to Assessment of Environmental Effects

13 RELEVANT STATUTORY PROVISIONS

The Resource Management Act 1991 requires this application to include an assessment of the proposed activity against the One Plan. Answering the following questions will satisfy this requirement. If you are unable to answer the questions below, or you believe your proposal is inconsistent with the relevant policies and documents discussed, it is recommended you seek professional planning assistance to help you with your application.

For a complete copy of the One Plan visit http://www.horizons.govt.nz/publications-feedback/one-plan

REGIONAL POLICY ASSESSMENT

The objectives and policies of the 'Land and Freshwater' (RPS-LF-FW) chapter are relevant to this application.

Is the activity consistent with the relevant provisions of the Regional Policy Statement? ☑ **YES** ☐ **NO**

Please provide reasons for your answer above

Refer to Assessment of Environmental Effects

Please list any other relevant objectives and/or policies of the Regional Policy Statement and provide an assessment of the activity against those objectives and/or policies.

Refer to Assessment of Environmental Effects

REGIONAL PLAN ASSESSMENT

Objective LF-FW-O2 and Policies LF-FW-P4, P5, P6, P7, P10, P11 and/or P12 of the 'Land and Freshwater' (RP-LF-FW) chapter of the Regional Plan may be relevant to this application.

Is the activity consistent with the relevant provisions of the Regional Plan? ☑ **YES** ☐ **NO**

Please provide reasons for your answer above:

Refer to Assessment of Environmental Effects

If there are other sections of the One Plan or any national planning document (e.g. NZ Coastal Policy Statement) that you consider are relevant, please provide an assessment of the activity against those relevant objectives/policies of the One Plan and/or national document.

Refer to Assessment of Environmental Effects

14 ADDITIONAL INFORMATION REQUIRED WITH THIS FORM

☑ Completed administration form (Form A)

☑ A SITE plan to scale showing:

- Site boundary
- Location of the proposed discharge
- Location of processes and discharge points
- Location of roads and property boundaries
- Location of any waterbodies in the vicinity of the discharge area
- Location of any bores/wells in the vicinity of the discharge area.
- Buildings and residential properties
- Location of any sensitive sites (e.g. historical places, sites of importance to iwi) in the proximity of the site
- Any rare, threatened or at-risk habitats

☐ Detailed plan of the treatment/discharge system and discharge area

☐ Operation and Management Plan (if applicable)

☐ Affected party approval form/s

Please contact the consents team on freephone **0508 800 800** if you require assistance with your application.

Application for
Resource Consent: Discharge to Water (General)

Form B: Activity Information and Assessment Form

horizons REGIONAL COUNCIL

A complete Administration Form (Form A) MUST accompany this Activity Information and Assessment Form (Form B) when lodging your application. The purpose of this form is to provide the applicant with guidance on information that is required under the Resource Management Act 1991. These forms are to act as a guide only, and Horizons Regional Council reserves the right to request additional information.

APPLICANT NAME Horowhenua District Council
(Refer to Form A)

1 APPLICATION PURPOSE

What is the purpose of this application *(select one)*

- [x] New consent
- [ ] Renewal of consent

Consent number ..... Expiry date .....

Consent term sought 35 Years
(Max. 35 years)

Resource consents are typically aligned with the relevant common catchment expiry dates in Policy IP-P5 of the One Plan.

2 LOCATION

Location of the proposed discharge Refer to Assessment of Environmental Effects

Address Refer to Assessment of Environmental Effects

Map coordinates (NZTM 2000) E Refer to Assessment of Environmental Effects N Refer to Assessment of Environmental Effects

Legal description Refer to Assessment of Environmental Effects

A detailed site map will be required with this application.

Refer to Assessment of Environmental Effects

What is the name of the waterbody that the discharge is into?

If the water body is unnamed then please note this and state which waterbody it is a tributary to.

Refer to Assessment of Environmental Effects

According to RP-SCHED1 of the One Plan, what Surface Water Management Area is this in?

Refer to Assessment of Environmental Effects

You can access this information via http://www.horizons.govt.nz/publications-feedback/one-plan/part-3-annexes/schedules

Describe the present state of the waterbody at the proposed location of the discharge. Please provide any reports or results of any testing you have undertaken.

Parameters to include in your description are; flow information, water colour/clarity, width of channel, average depth, land use surrounding the waterbody, bed material (e.g. rocky, silty, etc), bank material, streamside vegetation, erosion, fish life, invertebrate life, aquatic plants.

Refer to Assessment of Environmental Effects

What is the quality of the receiving waterbody before the discharge?

Provide sample results and interpretation of these results (e.g. against guideline values).

Refer to Assessment of Environmental Effects

3 DESCRIPTION OF PROPOSED ACTIVITY

What are the contaminant/s of concern to be discharged?

A contaminant is considered any substance which is likely to change the water into which it is discharged in any way. Water can also be a contaminant.

Refer to Assessment of Environmental Effects

What is the source of the contaminant and/or process that results in the discharge?

(e.g. municipal wastewater, industrial processes, water treatment, rural activity, contaminated stormwater, other).

Refer to Assessment of Environmental Effects

Is the discharge treated in any way before being discharged? ☐ **YES** ☑ **NO** N/A no contaminants in the water

Name the treatment system and describe the treatment process

(include the design specifications such as capacity of the system).

Refer to Assessment of Environmental Effects

If sludge/solid waste is generated as part of the treatment process, please state what happens to this sludge.

Additional consent will be required for the discharge of sludge to land.

Refer to Assessment of Environmental Effects

Describe the contaminant/s and expected quality of the discharge after treatment but before it enters its receiving environment. *Please provide the results from any water quality testing of the discharge. If you do not have this information, you will need to test your discharge. Indicate which contaminants have been identified in the discharge by ticking the boxes. Explain how the samples were taken (e.g. spot sample or composite sample) and attach the sampling results (laboratory analytical certificates) to this application.*

- ☐ Temperature °C
- ☐ Suspended solids g/m^3
- ☐ Faecal coliforms cfu/100 mL
- ☐ Toxic substances (e.g. PAHs, phenols) g/m^3
- ☐ Ammonia g/m^3
- ☐ pH
- ☐ BOD_5 g/m$^{3\backslash}$
- ☐ Heavy metals g/m^3
- ☐ Dissolved and total nutrients g/m^3
- ☐ Oil/grease g/m^3

Refer to Assessment of Environmental Effects

Date/s sample taken ..... Name of sampler .....

Location/s sample taken .....

Date/s of analysis: ..... Analysis conducted by .....

Indicate the sampling area(s) on the site map in Section 7.

Where appropriate describe the following

Physical characteristics of the discharge *(such as temperature, suspended solids, turbiduty).*

Refer to Assessment of Environmental Effects

Inorganic chemical characteristics of the discharge *(such as pH, free ammonia, organic nitrogen, total kjeldahl nitrogen, nitrites, nitrates, inorganic phosphorus, sulphate, metals).*

Refer to Assessment of Environmental Effects

Organic chemical characteristics of the discharge *(such as BOD5, VOC's).*

Refer to Assessment of Environmental Effects

Biological characteristics of the discharge *(such as faecal coliforms, specific micro-organisms, toxicity).*

Refer to Assessment of Environmental Effects

Provide details of the expected quality of the receiving waters (AFTER the point of discharge, at a point after reasonable mixing). Provide sample results for existing discharges or provide anticipated results.

Refer to Assessment of Environmental Effects

Indicate which contaminants have been identified in the receiving waters by ticking the boxes.
Attach the sampling results (laboratory analytical certificates) to this application.

- ☐ Temperature °C
- ☐ Suspended solids g/m^3
- ☐ Faecal coliforms cfu/100 mL
- ☐ Toxic substances
- ☐ Ammonia and dissolved reactive phosphorus
- ☐ pH
- ☐ BOD_5 g/m$^{3\backslash}$
- ☐ Heavy metals
- ☐ Nitrates
- ☐ Dissolved Oxygen g/m^3

Refer to Assessment of Environmental Effects

Date/s sample taken ..... Name of sampler .....

Location/s sample taken .....

Date/s of analysis: ..... Analysis conducted by .....

Please indicate the sampling locations (e.g. upstream, downstream, point of discharge) on your attached site plan.

Describe the method of the discharge.

Describe what measures will be put in place to prevent erosion or scour at the point of discharge.

Refer to Assessment of Environmental Effects

Describe the discharge outlet structure *(e.g. 300mm pipe, multi port diffuser, gravel trench etc).*

Refer to Assessment of Environmental Effects

Is the discharge continuous or intermittent? ☐ Continuous ☐ Intermittent

What will be the maximum discharging period?

..... hours per day

..... days per week

..... weeks per year

Refer to Assessment of Environmental Effects

Describe the expected volume and frequency of the discharge.

Maximum flow rate ..... litres per second

Maximum daily discharge ..... cubic metres per day

Average dry weather flow .....

Peak wet weather flow .....

Max. volume per annum .....

Please confirm that there are no other resource consents required for any other associated activities
(e.g. consent for the outlet strucutre, diverison and/or discharge to land).

Refer to Assessment of Environmental Effects

4 RULE ASSESSMENT

A number of the activities under the 'Land and Freshwater' (RP-LF-LW) chapter of the One Plan are permitted activities as long as you can meet certain conditions and standards. Please ensure your activity is not a permitted activity under the 'Land and Freshwater' (RP-LF-LW) chapter of the One Plan. If you require assistance, please contact the consents team at Horizons on freephone 0508 800 800.

Please indicate which rule of the One Plan your activity falls under Refer to Assessment of Environmental Effects

The 'Land and Freshwater' (RP-LF-LW) chapter can be accessed via *http://www.horizons.govt.nz/publications-feedback/one-plan.*

5 ASSESSMENT OF ENVIRONMENTAL EFFECTS

For your application to be considered, an assessment of environmental effects must be included. Please answer all of the questions below. Additional information may need to be provided depending on the scale and significance of your proposal.

Considering the Surface Water Management Area your proposed activity is in, are there any RP-SCHED2 values identified for this reach of the river? ☑ **YES** ☐ **NO**

You can access this information via *http://www.horizons.govt.nz/publications-feedback/one-plan/part-3-annexes/schedules*

If 'Yes', please identify these values and describe how you intend to avoid, remedy or mitigate adverse effects of the proposed discharge on each of these values?

Refer to Assessment of Environmental Effects

If there are any other discharges within the same catchment, what is the combined effect of these discharges (including the proposed discharge) on the receiving environment?

Refer to Assessment of Environmental Effects

Describe any noticeable change in the colour/clarity of the receiving waters that may result from the discharge.

Refer to Assessment of Environmental Effects

What environmental effects were considered when choosing the proposed method of disposal and location *(e.g. water table, dilution rates/mixing potential, proximity to waterbody)*?

Refer to Assessment of Environmental Effects

What are the cultural effects of the proposed discharge? Are there any statutory acknowledgements associated with the waterbody? *If your proposed activity falls under a Discretionary or Non-Complying Activity status, an assessment of cultural effects will be required. This should be informed by [written] feedback from the relevant iwi and/or hapū. For indicative rohe and contact details of your local iwi and/or hapū please visit http://www.tkm.govt.nz/.*

Refer to Assessment of Environmental Effects

6 EFFECT ON STATUTORY ACKNOWLEDGMENTS

Is the activity on, adjacent to, or may affect land that is subject of a statutory acknowledgment? ☐ Yes ☑ No

List of statutory acknowledgments:
Ngāti Tūwharetoa (Bay of Plenty) Claims Settlement Act 2005
Ngaa Rauru Kiitahi Claims Settlement Act 2005
Ngāti Apa (North Island) Claims Settlement Act 2010
Rangitāne o Manawatu Claims Settlement Act 2016
Rangitāne Tū Mai Rā (Wairarapa Tamaki nui-ā-Rua) Claims Settlement Act 2017
Ngāti Rangi Claims Settlement Act 2019

Information on statutory acknowledgments can be found on the Horizons website: **https://www.horizons.govt.nz/about-our-region-and-council/iwi-and-hapu**

If yes, Council must have regard to the statutory acknowledgments. We recommend that applicants considering undertaking works that may affect a statutory acknowledgment make contact with local iwi and/or hapū before the lodgement of a consent application to determine if there are any effects on the statutory acknowledgment.

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Are the proposed works in the Whanganui catchment? ☐ **YES** ☑ **NO**
Please note that this covers a large area. If you are unsure, please contact the consents team.

If yes, the Whanganui River and its wider catchment is the subject of the Te Awa Tupua (Whanganui River Claims Settlement) Act 2017. Council must have regard to the values of Te Awa Tupua when making a decision on any application we receive (regardless of activity status). On that basis, we recommend that parties considering undertaking works within the Whanganui catchment make contact with Ngā Tāngata Tiaki o Whanganui and local iwi and/or hapū before lodgement of a consent application to confirm any requirements under Te Awa Tupua and obtain feedback on the proposed works.

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Are the proposed works in the Whanganui catchment? ☐ **YES** ☑ **NO**
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9 GOOD MANAGEMENT PRACTICES AND MITIGATION MEASURES

Please include a description of the monitoring or good management practices to be undertaken to help avoid, reduce, remedy or mitigate the actual and potential effects on the environment.

What monitoring and management do you proposed to ensure any potential adverse effects on the environment are avoided, remedied or mitigated? *(E.g. discharge monitoring, receiving water monitoring, ecological surveys, toxicity tests).* **Include details on what is to be monitored, when, how and why.**

Refer to Assessment of Environmental Effects

What contingency measures are proposed to deal with any system malfunction or failures so as to prevent unauthorised, uncontrolled, or only partially treated discharge to the environment?

Refer to Assessment of Environmental Effects

Describe how the equipment controlling the discharge to prevent equipment failure will be maintained and operated
(E.g. measures to exclude stormwater from the system, desludging, equipment maintenance).

Refer to Assessment of Environmental Effects

What will be done to minimise and remediate any effects in the event of equipment failure?

Refer to Assessment of Environmental Effects

10 CONSIDERATION OF ALTERNATIVES

Please include a description of any possible alternative locations or methods for undertaking the activity and why these alternatives have not been selected.

Refer to Assessment of Environmental Effects

11 CONSULTATION/AFFECTED PARTIES

Please include evidence of any consultation undertaken for this application. This may include (but not be limited to) consultation with adjoining landowners, other consent holders in the immediate area, Iwi, government departments/ministries (e.g. DOC), territorial authorities and recreational associations (e.g. Fish and Game New Zealand). Please ensure that you have considered any statutory acknowledgements in the Horizons Region. For more information visit (http://www.horizons.govt.nz/about-our-region-and-council/iwi-and-hapu/statutory-acknowledgements).
If you are in doubt about who you should be talking to the call a member of the consents team on freephone **0508 800 800**.

Please provide details of those you have identified as parties who may be affected. If you have discussed your proposal with any of these parties, please record any comments made by them and your response to them, and submit this with your application.

Name Refer to Assessment of Environmental Effects

Address .....

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☐ Affected party approval form attached

Name .....

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12 NATIONAL ENVIRONMENTAL STANDARDS

NATIONAL ENVIRONMENTAL STANDARDS FOR SOURCES OF HUMAN DRINKING WATER (NES-HDW)

Are there any public water supplies that could be affected by your proposal? ☑ **YES** ☐ **NO**

An assessment under the NES-HDW will need to identify any sources of human drinking water that supply more than 25 people that might be affected by the discharge. Horizons Regional Council holds a list of such water supplies within its region and will be able to provide assistance when identifying water supplies within the vicinity of the activity.

Discussion with the water supply operator may also be beneficial in determining whether the supply could be affected and what measures can be taken to ensure the quality of the water supply is maintained.

Refer to Assessment of Environmental Effects.

Note: Public water supply 'affected' is the same activity for which consent is sought.

Please state any other NES that you consider may be relevant to your activity and provide an assessment against that NES.

Refer to Assessment of Environmental Effects

13 RELEVANT STATUTORY PROVISIONS

The Resource Management Act 1991 requires this application to include an assessment of the proposed activity against the One Plan. Answering the following questions will satisfy this requirement. If you are unable to answer the questions below, or you believe your proposal is inconsistent with the relevant policies and documents discussed, it is recommended you seek professional planning assistance to help you with your application. For a complete copy of the One Plan visit *http://www.horizons.govt.nz/publications-feedback/one-plan.*

REGIONAL POLICY ASSESSMENT

The objectives and policies of the 'Resource Management Issues of Significance to Hapu and Iwi' (RPS-RMIA) chapter and the 'Land and Freshwater' (RPS-LF-FW) chapter are relevant to this application.

Is the activity consistent with the relevant provisions of the Regional Policy Statement? ☑ **YES** ☐ **NO**

Please provide reasons for your answer above

Refer to Assessment of Environmental Effects

Please list any other relevant objective and /or policies of the Regional Policy Statement and provide an assessment of the activity against those objectives and/or policies.

Refer to Assessment of Environmental Effects

REGIONAL PLAN ASSESSMENT

Objective LF-LW-O2nd Policies LF-LW-P4, P6, P7, P11 and/or P12 of the 'Land and Freshwater' (RP-LF-LW) chapter of the Regional Plan may be relevant to this application.

Is the activity consistent with the relevant provisions of the Regional Plan? ☑ **YES** ☐ **NO**

Please provide reasons for your answer above

Refer to Assessment of Environmental Effects

If there are other sections of the One Plan or any national planning document (e.g. NZ Coastal Policy Statement) that you consider are relevant, please provide an assessment of the activity against those relevant objectives/policies of the One Plan and/or national document.

Refer to Assessment of Environmental Effects

14 ADDITIONAL INFORMATION REQUIRED WITH THIS FORM

- [x] Administration Form (Form A)
- [x] A SITE plan to scale showing:
  - Site boundary
  - Location of the discharge point/s
  - Sampling locations
  - Location of roads and property boundaries
  - Location of any waterbodies in the vicinity of the discharge area
  - Location of any bores/wells in the vicinity of the discharge area
  - Locality of the discharge and system design
  - Buildings and residential properties
  - Location of any sensitive sites (e.g. historical places, sites of importance to iwi) in the proximity of the site
  - Any rare, threatened or at-risk habitats
- [ ] Sampling results detailed Section 3 (if relevant)
- [ ] Management Plans (if applicable)
- [ ] Affected party approval form/s

Please contact the consents team on freephone **0508 800 800** if you require assistance with your application.

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Levin Water Supply
Water Harvesting & Resilience Project

Assessment of Environmental Effects for Abstraction of Water from the Ohau River and Activities to Enable Augmentation of the Levin Water Supply via Water Harvesting & Reservoir Storage

Horowhenua District Council

November 2024

FOR LODGEMENT

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Appendix H	Ecological Assessment - Reservoir Site
Appendix I	Construction Management Plan Content
Appendix J	Erosion and Sediment Control Plan
Appendix K	Functional Need Assessment for Reservoir as Specified Infrastructure
Appendix L	Cultural Offset Management Plan
Appendix M	Proposed Consent Conditions

1 INTRODUCTION AND REASONS FOR THE APPLICATION

Horowhenua District Council (the Council) provides a public water supply to the community of Levin. The current consent (ATH-1991006011.03) authorises the abstraction of up to 15,000 m^3/day of water from the Ohau River to meet the public water supply needs of Levin.

At the time that the consent was granted (2017), it was anticipated that this allocation would be sufficient to meet the projected demand through until the expiry of consent in 2042. However, Levin has been growing at a significantly faster pace than projected and it is now clear that the existing allocation is not sufficient to meet the community's needs through to 2042. When granted in 2017, it was anticipated that there would be a total of 2% growth over 50 years. However, the growth that has occurred since grant of consent has been approximately 2% each year.

The Council has undertaken significant investment in network management and pressure controls to ensure it can actively monitor and manage network efficiency and to enable network leakage to be brought within best practice benchmark standards. It has also recently initiated universal water metering, and is in the process of installing water meters with leak detection capability on all properties. These improvements have resulted in the average water demand being generally consistent with what is calculated as reasonable and justifiable for a public water supply under Policy LF-FW-P15 of the Horizons Regional Council's One Plan. Despite these significant improvements and due to the pace and scale of growth in Levin, additional allocation is required to meet the community's projected growth needs.

In addition to ensuring that adequate quantity of supply is available to meet the human health and drinking water needs of the Levin community, the Council is seeking to improve the way in which it takes water from the Ohau River. The National Policy Statement for Freshwater Management 2020 (as amended in 2024), herein referred to as NPSFM, introduced the fundamental concept of Te Mana o Te Wai into freshwater management in Aotearoa New Zealand and the NPSFM requires that freshwater is managed in a way that gives effect to Te Mana o Te Wai. To do this, the Council seeks to reduce its reliance on the abstraction of water from the Ohau River at times of minimum flow as far as possible. This will reduce potential adverse effects on the River and ensure the health and well-being of the water body is protected and provided for. Additionally, Council proposes a low flow abstraction management regime within which iwi / hapū have a direct role.

At the moment, there is only about 1 day's storage in the system. The Council also seeks to increase the resilience of the Levin drinking water supply to the effects of climate change and variability, including in particular highly variable and extreme weather conditions, and improve resilience to natural hazards including earthquakes, by providing alternative/additional supply within the system that is not reliant on the river take. The provision of storage provides an alternative water source during high flow / high turbidity periods in the River. High flow periods in the River can result in very high turbidity such that water cannot be treated to drinking water standards in sufficient quantities to maintain uninterrupted supply. Such events are infrequent, but can be expected to increase with climate change, and have significant consequences in terms of public health and community wellbeing. An example occurred in June 2021 when high turbidity in the raw water resulted in the treatment plant not being able to produce drinking water fast enough to meet community demand and supply to the community was interrupted. Further, the River is located on a fault line, and there is potential for the supply to be interrupted in the event of a significant earthquake. Recent post-earthquake experience in New Zealand has demonstrated a need to have an alternative drinking water supply to meet post-earthquake needs.

Therefore, to ensure that the Levin Water supply take and operational regime gives effect to Te Mana o te Wai and is able to meet projected growth needs and to achieve a resilient supply (ie in the order of 30 days' storage), the Council proposes to construct a large off-river water supply

reservoir on Council owned land located off Poads Road, approximately 3 km upstream of the existing intake.

In summary, the key reasons for the application are:

- To reduce the need to take from the river when it is below minimum flow thereby reducing the effects of the take on the River;
- To provide long term supply to Levin to meet growth projections which are significantly greater than when the existing Levin water supply consent was granted;
- To provide resilience within the Levin drinking water supply network by introducing large scale water storage and reducing risk associated with drought/low flow, high flow and highly turbid source water and emergency supply;
- To reduce the need to abstract large volumes of water from the existing intake structure, given sedimentation issues and the need to periodically scarify the river bed;
- To enable the construction, maintenance and operation of a new intake on the Ohau River and large off-river reservoir to be able to harvest and store water for later supply to the community;
- To provide flexibility and optionality within the water take permit structure to ensure security of supply and efficient use of resources and existing infrastructure by:
    - Providing flexibility between the two intake sites (being the existing intake site and a new reservoir intake site).
    - Ability to take the full consented volume from the new reservoir intake in emergency situations.
    - Providing for a short term abstraction of water for construction of the NZTA Ōtaki to North Levin project in order to enable efficient allocation of water for a project of national significance, which will have wide ranging benefits for the district.

This Application seeks to secure all regional resource consents for the activities required to provide the proposed augmentation to the Levin Water Supply. District Council planning approvals are being sought separately, noting that the project is enabled by the network utility provisions of the District Plan (i.e., it is considered to be a Permitted Activity) and that the Council intends to designate the reservoir site.

In summary, this Application seeks consent for the following activities:

- A new water permit to enable water storage to be provided within the Levin Water Supply System (via use of the new reservoir). The new water permit will replace the existing water take permits.
- Construction, operation and maintenance of a new intake structure and associated riparian works in order to improve optionality within the Levin Water Supply System and address and improve operational issues being experienced at the existing water treatment plant intake as well as to reduce adverse effects to the river bed associated with maintenance of the existing intake.
- Large scale earthworks to enable the construction of the off-river reservoir, including consent to undertake earthworks within, and within 100 m of, a natural inland wetland (marginal classification) located within the reservoir footprint.
- Construction and use of a new pipeline bridge to enable connection of the new reservoir to the existing water treatment plant.
- Intermittent discharge of overflow from the reservoir.
- Diversion and discharge of groundwater from under the reservoir.
- Any consents necessary to undertake wetland and stream enhancement, weed and plant-pest removal, and restoration on the lower terrace and floodplain area of the reservoir site in order to

implement the Cultural Offset Management Plan (COMP) agreed with iwi as appropriate mitigation measures for the effect of the water take and associated activities on the mauri of the awa.

This document has been prepared in accordance with the requirements of section 88 and Schedule 4 of the Resource Management Act 1991 (RMA) to support an application by the Horowhenua District Council ('the Applicant', 'the Council', 'HDC' or 'District Council') for resource consent from the Manawatū-Whanganui Regional Council ('Horizons' or 'Regional Council').

The Applicant requests that this application be processed by way of Public Notification.

2 CONSENTING FRAMEWORK

2.1 Consenting Approach and Other Consents Required

The consenting approach for this project has been to undertake an iterative process for developing a pragmatic and effective option for increasing resilience in the Levin Water Supply, applying key statutory policy drivers and the regulatory framework alongside technical optioneering and wider considerations for obligations to Te Tiriti o Waitangi partners and good environmental outcomes.

There are three key consenting phases, as described below. The water take permit and associated activities as described within this application are the key, primary activities for which resource consent needs to be secured. This is due to the significance of these activities for the Awa and within the planning framework (refer particularly to the discussion of the key policy drivers for the project in section 5 below) and for iwi / hapū, and the criticality of needing to secure a different take regime in order to fill and utilise the reservoir. In determining the more detailed logistical aspects of the proposal (eg location of pipes and equipment and realignment of Poads Road) it is important that there is sensitivity for the potentially affected landowners and ability to work iteratively with them. This process requires a not insignificant level of detail and time, and the Applicant needs to progress with the critical regional consents as these discussions and processes continue.

2.1.1 Securing Additional Core Allocation (Completed)

Throughout the project, critical pathways have been identified in order to ensure that matters arising could be appropriately addressed within the context of the above drivers. One of these was securing consent to take core allocation water (as per the One Plan), given advice from Regional Council that available core allocation was limited. It became clear during 2022 via assessment of water supply options that an alternative source supply in a different location from the Ohau River was likely not possible nor pragmatic and that storage near the existing source was necessary to increase resilience in the network. It was critical then that the District Council ensure that it had sufficient water take optionality to be able to fill any new storage (ie reservoir) so that this could continue to be a viable option. The ability to fill the reservoir needed to be independent of any additional consenting requirements for a new take from a new intake structure, given the uncertainty associated with consenting of supplemental (ie non core allocation) water takes under the One Plan.

Hence, in March 2022, the Council applied for consent (new abstraction from adjacent to the proposed reservoir site) to take 3,564m^3/day of water, being the remaining core allocation that Horizons had advised was available from the Ohau River, for the purpose of filling the proposed storage reservoir.

Soon after lodgement of that application, the Council was advised by Regional Council that previous advice regarding the volume of core allocation remaining for the Ohau awa was in fact incorrect and that only 409m^3/day of core allocation was available. There was some discussion between the councils, as drinking water supplier and consent authority, regarding whether or not 'there was any

point' to apply for the remaining core allocation, given that it was significantly less than the volume originally sought. From the drinking water supplier point of view, there did remain a need to apply for this lesser volume to provide some certainty regarding the ability to fill the reservoir, and it was also considered prudent to secure what water was available given that growth projections indicated that the need for drinking water for Levin may exceed the amount able to be supplied under the current regime by 2025. District Council subsequently amended the application[1] to seek only the 409m^3/day remaining core allocation and that consent (ATH-2022203743.00) was granted as a controlled activity on 15 November 2022.

2.1.2 Securing Key Regional Consents (this Application)

The next critical pathway identified for the project, in terms of consenting and the relevant RMA framework, is to secure the key resource consents from Regional Council to ensure that the project is able to go ahead with a water take permit with the correct optionality to enable water harvesting and security of supply, and the ability to construct the reservoir, new intake and pipe bridge, as well as the ability to implement cultural mitigation plans, being the activities for which consent is sought by way of this application.

2.1.3 District Council Approvals

Consultation by the project team with the District Council as consent authority has indicated that the construction of the reservoir appears to be a permitted activity under the District Plan. Likewise, it is expected that new pipework will be permitted under the network utility provisions of the Plan. The Applicant recognises however that the reservoir introduces large scale infrastructure into the local environment and critically, will provide critical long-term community infrastructure that requires protection including through to any water service entity that may be required to manage this facility in the future (depending on the outcome of Local Water Done Well water reform processes). Hence the appropriate consenting pathway has been determined to be to designate the reservoir site.

The Applicant owns the site upon which the reservoir will be located, noting that some of the intake infrastructure is located within the neighbouring property and engagement and discussion with that landowner is ongoing. It is also noted that part of the reservoir is proposed to be on what is legal road, and the specific legal and property arrangements are in the process of being established to support a Notice of Requirement. The proposal includes moving the current alignment of Poads Road such that it is in the paper road corridor, and the details of this are to be confirmed with the adjacent land owner given that access to that property would be changed and new access is to be satisfactorily established. An Outline Plan of works will be submitted for confirmation at the time that detailed design for the reservoir is completed.

2.2 Existing Consents

Horowhenua District Council holds the following consents from Horizons Regional Council in relation to the Levin Water supply take and treatment plant:

[1] *Letter to Sarah Sandilands, Horizons Regional Council from Annette Sweeney, Good Earth Matters Consulting on behalf of Horowhenua District Council dated 28 March 2022 Project Ref: 27036.001.*

Table 2.1: Existing Consents

Consent No.	Consent Type	Activity	Granted	Expires	Activity Status
ATH-1991006011.03	Water Take - Surface Water	Abstract 15,750 m^3/day of surface water from the Ohau River for municipal water supply and treatment plant backwash purposes at Gladstone Road, Levin. (note: any abstraction above 15,000 m^3/day is non-consumptive and must be returned to the river within 400 m of abstraction).	03.08.2017	01.07.2042	Non-complying
ATH-2022203743.00	Water Take - Surface Water	Abstract 409m^3/day surface water from the Ohau River for municipal water supply purposes at Poads Road, Levin (enables abstraction to occur 100 m up and downstream of new intake site).	15.11.2022	05.12.2027 See Note below	Controlled
ATH-2008010962.02	Land Use - River Bed	Gallery maintenance (periodic scarifying, flushing, backwash, flood debris removal).	26.08.2015	06.05.2043	Discretionary
ATH-1995003230.01	Discharge Permit	Discharge 1,000m^3/day of WTP reservoir overflow water, rain water run-off, filter cleaning and backwash water from the twin settlement treatment ponds to an Ohau River open drain at Gladstone Road, Levin.	20.03.2015	01.07.2042	Discretionary

Note: A short term consent only was granted as Horizons Regional Council understood that this application would be lodged within this timeframe.

This Application does not propose any changes to the existing land use (river-bed) consent (ATH-2008010962.02) and the existing discharge permit (ATH-1995003230.01). The existing water take permits (ATH-1991006011.03 and ATH-202203743.00) will be surrendered subject to grant of the consents sought by this application.

2.3 Resource Consents Sought and Activity Status

This Application seeks consent to replace two existing surface water take permits (ATH-1991006011.03 and ATH-2022203743.00) held by Horowhenua District Council for the taking of water from the Ohau River in order to supply drinking water for Levin, with a single new consent that is subject to a different take regime than provided for under the existing consents and to secure supplementary allocation for the primary purpose of filling the proposed reservoir. Concurrently, consent is sought for land use activities including the construction, operation and maintenance of a

new intake structure within the bed of the Ohau River; construction of the off-river reservoir including earthworks impacting a marginal natural inland wetland; and construction of a new pipeline bridge over the Ohau River to enable connection of drinking water pipes from the new proposed drinking water reservoir to the existing Levin drinking water treatment plant. Consent is also sought for a new discharge permit for the diversion and discharge of groundwater from below the proposed reservoir to the Ohau River and an intermittent, low frequency discharge of stored reservoir water to the Ohau River in the event of overtopping and if maintenance[2] draw down is required.

The proposal falls to be considered as a non-complying activity under Horizons Regional Council's One Plan and the National Environmental Standards for Freshwater (refer discussion in Section 8).

The specific resource consents sought by way of this Application for the above activities under the One Plan and NES-Freshwater are as follows:

Table 2.2: Resource Consents Sought

Activity	One Plan Rule	Activity Status	Site Details
Water take permit to abstract 16,159m^3/day from the Ohau River (Being 15,409 m^3/day of consumptive take and 750 m^3/day of non-consumptive take) (Core Allocation).	LF-TUD-R47 Takes and uses of surface water not complying with core allocations or takes and uses of water taken at or below minimum flow	Non-Complying	Ohau River at existing and new intake structures; Short term take at Ō2NL Project site for Ō2NL construction water.
Water take permit for supplementary allocation to enable water harvesting at times when the River is above median flow and which, in total is not to exceed 10% of the actual flow in the river at the time of abstraction. (Supplementary Allocation).	LF-TUD-R47 Takes and uses of surface water not complying with core allocations	Non-Complying	Ohau River at new intake structure.
Land use (bed of river) consent to construct, operate and maintain a new water intake structure (infiltration gallery) for drinking water supply purposes including intermittent air backwash of the system.	LF-AWBD-R76 Activities in the bed of a river that do not comply with other rules LF-LAND-R8 Vegetation Clearance, Land Disturbance	Discretionary Discretionary	Lot 1 DP 12594 116 Poads Road
Land use (bed of a river) consent to construct, operate and maintain a water pipe bridge over the Ohau River to convey water from the water storage reservoir to the drinking water treatment plant.	LF-AWBD-R68 Activities affecting RP-SCHED2 Value of Flood Control and Drainage	Discretionary	Road Reserve [DP 555714]

[2] *Maintenance in this context being for the purpose of maintaining either the physical assets, or maintaining water quality of stored water.*

Activity	One Plan Rule	Activity Status	Site Details
Land use (earthworks) consent to construct off-river reservoir and associated infrastructure of approximately 855,000 m^3 total volume.	LF-LAND-R6 Large-scale land disturbance, including earthworks	Controlled	Lot 9 DP 555714
Discharge permit for the intermittent discharge of stored water from the reservoir via spillway to the Ohau River if overtopping occurs or if maintenance draw down is required.	LF-LW-R38 Discharges of water or contaminants into surface water that do not comply with other rules or are not otherwise regulated	Discretionary	Lot 1 DP 12594 116 Poads Road; and Lot 9 DP 555714
Diversion of groundwater under the reservoir.	LF-TUD-R51 Diversions that do not comply with permitted activities and controlled activity rules	Discretionary	Lot 9 DP 555714
Discharge permit for the discharge of groundwater from under the water storage reservoir to water or to land which may result in some overland flow to the Ohau River.	LF-LW-R38 Discharges of water or contaminants into surface water that do not comply with other rules or are not otherwise regulated	Discretionary	Lot 9 DP 555714
Planting and Restoration in and around a rare habitat (wetland).	ECO-R2, Some activities within rare and threatened habitat	Non-Complying Activity	Lot 9 DP 555714 (COMP Area)
Land use (bed of a river) consent to construct shallow bores for abstraction of water in the vicinity of SH1 bridge.	RP-LF-AWBD-R54, Structures and disturbances involving a reach of river or its bed with RP-SCHED2 Values of Natural State, Sites of Significance - Aquatic, and Sites of Significance – Cultural	Discretionary	Ohau River in vicinity of Ō2NL Project site
Activity	**NES-Freshwater**	**Activity Status**	**Site Detail**
Earthworks within and within 100 m of a natural inland wetland (marginal classification), in a manner that will result in complete drainage of the wetland, required for the construction of specified infrastructure.	Regulation 45	Discretionary Activity	Lot 9 DP 555714
Discharge of groundwater within and within a 100 m setback from a natural inland wetland.	Regulation 39(3A)	Restricted Discretionary Activity	Lot 9 DP 555714 (COMP area)

2.4 Consent Duration

The term of consent sought is 35 years. The majority (15,000 m^3/day plus 750 m^3/day of non-consumptive take or 97% of the District Council's existing allocation) is consented through to July 2042. The Applicant seeks a 35-year consent term in this application, which would serve to extend this allocation timeframe a further 17 years.

This term is appropriate given the level of reasonable and justifiable need for the water as demonstrated within this Application; the level of planning and investment undertaken by the Applicant in developing the proposal and its importance for contributing to a reliable and resilient drinking water supply for Levin and surrounding communities; and because the proposed activities will not result in a more than minor adverse effects on the environment.

3 DESCRIPTION OF EXISTING WATER SUPPLY SYSTEM AND THE PROPOSED RESERVOIR AND INTAKE SITE

This section includes a detailed description of the existing Levin Water supply system; how the Council is managing the water supply network and community demand to achieve efficient water use; and details of projected community growth and what this means in terms of water demand and allocation requirements.

It also includes a detailed description of the sites at which the works proposed in this application are to be undertaken, including the new reservoir intake site and riparian area; reservoir site; cultural offset mitigation area, and proposed pipe bridge.

3.1 Levin Water Supply System

The Levin Water supply system abstracts water from an existing subsurface intake on the Ohau River approximately five kilometres south-east of Levin centre. The reticulation network provides water to domestic, community, commercial and industrial uses and delivers water for both potable and non-potable uses. However, as the water is supplied via a single reticulation network, all water is required to meet drinking water standards.

The Levin Water supply has a resource consent to abstract water from the Ohau River via an infiltration gallery. The consent enables the council to take up to 15,000 m^3/day under normal conditions. When the river is below its minimum flow defined in the Regional Council's One Plan (0.820 m^3/s), the Council is required to reduce its abstraction to 13,000 m^3/day. Further, an additional 750 m^3/day may be taken for non-consumptive purposes within the treatment process. This additional non-consumptive take must be returned to the river within 400 m of the abstraction point.

Water is treated to NZ Drinking Water Standards[3] via a Water Treatment Plant (WTP) at the same site. The treatment process currently consists of clarification, UV disinfection and chlorine dosing.

There is 12,000 m^3 of post-treatment water storage at the WTP site. This storage comprises a 6,000 m^3 steel tank installed in 2017 and two older concrete tanks with a combined capacity of 6,000 m^3. These storage tanks provide only approximately 1.25 days storage at current average demand and therefore their functionality is limited to assisting to meet short-term (ie diurnal variations) peak demand and providing firefighting capacity. The tanks do not provide sufficient storage to cater for growth, enable water harvesting, or to meet any extended interruptions to the supply. Further, it is expected that the available storage would decrease to approximately 6,000 m^3 in the event of a major earthquake given the age of the older tanks and their likely susceptibility to cracking in a major seismic event. Council is currently planning to construct some additional post-treatment storage, however this will be of similar scale to the existing storage and by no means sufficient enough to provide for growth or significantly improve resilience of the scheme.

[3] *Water Services (Drinking Water Standards for New Zealand) Regulations 2022 and in accordance with Taumata Arowai's Drinking Water Quality Assurance Rules which specify how water suppliers must demonstrate compliance with the Standards.*

Treated water is delivered to the Levin urban water reticulation network which currently services approximately 22,000 people across 8,500 properties throughout Levin and parts of Ohau and Hokio Beach. Feasibility studies have previously been undertaken to connect the currently self-serviced areas of Ohau and Waitārere Beach to the Levin Water supply in order to provide those communities with a safe and sufficient supply of water. Securing supplementary allocation from the Ohau River and constructing the proposed reservoir would provide sufficient water to meet the needs of these communities from the Levin Water supply, should Council determine this is the preferred solution for those communities in the future. The Council's 2024-2044 Long Term Plan's Infrastructure Strategy states that "the requirements for a reticulated water supply to growing smaller settlements, such as Waitārere Beach and Ohau … will only be considered once a long-term water source for Levin has been secured" (i.e. this application). For the absence of doubt, the activity which is subject to this application includes any future provision of water from the Levin water supply scheme to service Waitārere Beach, Ohau and other communities in proximity to the existing water supply network.

The Council is required to manage the supply in accordance with a Water Demand Management Plan that is reviewed no less frequently than every three years.



Figure 3.1: Location Overview

3.1.1 Statutory Obligation to Provide Water Supply and Plan for Future Growth

The Council has several statutory and policy obligations that require it to meet the community's water supply requirements now and into the future. These include obligations under the Local Government Act, Water Services Act and via the National Policy Statement on Urban Development.

Local Government Act

The purpose of the Council, as defined in the Local Government Act (LGA), s10(1)(b) is to *"promote the social, economic, environmental, and cultural well-being of communities in the present and for the future."* Provision of water services is a fundamental contributor to community wellbeing.

Section 125 of the LGA requires the Council to *"inform itself about the access that each community in its district has to drinking water services by undertaking an assessment of drinking water services"* and, consider the findings and implications of this assessment in relation to its *"current and future infrastructure strategy and long-term plan"* (section 126). A likely outcome of these assessments (combined with the Water Services Act discussed below) is that the Council will be required to expand its water services to currently unserviced communities if there is a risk to the community arising from the absence or deficiency of a water service.

Under section 131 of the LGA, Council may only close a water service if there are 200 or fewer persons served by that water supply. Therefore, there is an obligation to maintain the Levin Water supply service[4].

Water Services Act

The Council is a water services provider in terms of the Water Services Act 2021. Under this Act, the Council has a duty to ensure that safe drinking water is supplied (s21) and that there is a "sufficient quantity of drinking water" at each point of supply (ie at each property supplied) (s25).

The Water Services Act also sets up an accountability and transparency mechanism by which water service providers are required to report on their performance with respect to environmental performance measures. For water services, this includes a series of industry best practice measures for assessing the efficiency of the water supply network. This process provides for regulatory oversight by Taumata Arowai and public reporting on the performance of water supply networks across the country. This is discussed further in the Options Report in Appendix A. This process ensures that common and appropriate measures for assessing network efficiency, including leakage, are used across all Council water supplies in the country.

Under the Water Services Act requires the Council to undertake its functions, powers, and duties in a manner that gives effect to Te Mana o te Wai.

National Policy Statement on Urban Development 2020

The Council has responsibilities under the National Policy Statement on Urban Development 2020 (NPSUD). The District Council is classified as a Tier 3 local authority under the NPSUD. In accordance with Policy 2, the Council must "*at all times, provide at least sufficient development capacity to meet expected demand for housing and for business land over the short term, medium term, and long term*." Clauses 3.2 and 3.3 of the NPSUD define what is meant by "sufficient development capacity". That states that the development capacity must be plan enabled, **infrastructure ready** and feasible and reasonably expected to be realised.

"Plan-enabled" and "Infrastructure ready" is defined in clause 3.4. For development capacity to be considered "plan-enabled", short term requirements must be at least zoned in the District Plan; medium term requirements must be either zoned in the operative or proposed District Plan and, long term requirements must be either zoned in the operative or proposed District Plan or identified on a Future Development Strategy.

For development capacity to be considered "infrastructure ready": short term needs must already have infrastructure in place; medium term needs must either have infrastructure in place or funding to support that infrastructure in the Long Term Plan; and long term needs must either be in place,

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[4] *Note that, the Local Water Done Well reform programme is requiring councils to consider its water service delivery plans including whether or not to join with other councils and provide services via council controlled organisations or similar entities. Irrespective of any future reform, legislative arrangements will require the ongoing operation of the Levin water supply. Further, the requirement to provide for community wellbeing and to assess the risk to communities in relation to access to drinking water services is likely to remain with the Council.*

have funding available in the Long Term Plan or, as a minimum, the development infrastructure must be identified in the Council's infrastructure strategy.

Under the NPSUD 'long term' is defined as 10 to 30 years. Further, under the Local Government Act (s101B), the Council is required to develop an Infrastructure Strategy which has a minimum planning horizon of 30 years.

It is therefore appropriate that, to ensure that the obligation to ensure infrastructure ready development capacity is able to be given effect to, Council has sufficient water rights to be able to meet the projected community need for a minimum of 30 years.

3.1.2 Constraints and Risks Associated with Existing Water Supply

There are a number of constraints and risks associated with the existing water supply that can affect the ability of Council to meet the current demand. The proposed improvements which are the subject of this application allow the Council to reduce these risks, in addition to providing supply to meet growth needs. The key risks include:

Existing Intake

The existing infiltration gallery, located in the bed of the Ohau River adjacent to the WTP, was constructed in 1993. It comprises two arms orientated parallel to the bed of the river. The intake is a 750 mm diameter Aluflo slotted pipe. The upstream arm is 175 m long and the downstream arm is 66 m long. Both arms connect to a common intake chamber from which water is abstracted and pumped to the treatment plant.

While the existing intake can, and regularly does during summer periods, enable abstraction up to near the existing consented limited, it is preferable for this intake to be operated at an overall lower abstraction rate for operational and resilience reasons. At present, the Council needs to undertake regular scarification of the riverbed in order to maintain the required level of sub-surface flow into the intake pipework. Further, there is some concern regarding the structural resilience of the intake chamber. Enabling the existing intake to operate at a lower abstraction rate would increase the remaining life of the asset, and would reduce the amount of bed disturbance required to maintain the supply.

High Turbidity River Flows

High flows in the Ohau River can lead to high turbidity in the source water which impacts treatment plant production rates. In June 2021, elevated turbidity in the source water resulted in the treatment plant not being able to produce compliant water in sufficient quantities to maintain supply to the network. This resulted in treated water reservoir levels being depleted and supply to the community being interrupted. Some industries and businesses were required to cease operation because of the shortage of water supply. Tanker water was made available for residential users in some places. Following heavy rain on 27 June 2021, Council issued a notice (28 June 2021) requesting all residents to "reduce or stop using water immediately". The notice stated that "*Due to the most recent rainfall event, the water treatment plant [is] struggling to effectively treat the muddy river water for our drinking water supplies. The community demand including residents and businesses connected to the town water supplies are exceeding what the treatment plant can deliver. There is a real risk that the water supply will run-out and the community will need to rely on bottled water or water tank supplies to service their minimum requirements.*[5]" It stated that residents could expect this situation to continue for at least 48 hours. Water tankers were deployed throughout the community to provide drinking water.

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[5] *HDC news published on HDC website, 28 June 2021.*

Council staff[6] stated that turbidity levels in the river were five times the level required for the treatment plant to meet the drinking water standards.

While this is an infrequent situation, it is one which creates significant disruption to the community including significant impacts on social and economic wellbeing.

Abstraction when the River is below Minimum Flow

The current system has only minor post-treatment storage (just over 1 day at average demand) and therefore there is no alternative supply during times when the river is at or below minimum flow. Ongoing abstraction during these times is therefore required to meet the community's needs. This is permitted by the existing consent but is not considered to be consistent with Te Mana o te Wai.

The Options report in Appendix A discusses the frequency and duration of minimum flow events in the River.

From the flow record available, the frequency and duration of minimum flow occurring in the Ohau River at Rongomatane is as follows:

- The river has entered minimum flow conditions on 6 years since 1979 ie on average, 1 in every 14 years.
- The maximum number of days per year that the river is below minimum flow is 50 days. This occurred in the 2003/2004 summer.
- The maximum consecutive number of days that the river is below minimum flow is 25 days. This also occurred in the 2003/2004 summer. In the other five years that minimum flow conditions occurred, the maximum consecutive number of days that the river was below minimum flow was less than 10 days.
- When the river has fallen below minimum flow, this has always been in January to May. The river has not fallen below minimum flow in June to December.
- The months that have most frequently experienced minimum flow conditions are March and April (that is, minimum flow is more likely to occur in late summer/early autumn). For the flow record available (1979 – 2021)[7], the total number of days when the river was below minimum flow was:
  - January: 13 days
  - February: 18 days
  - March: 38 days
  - April: 29 days
  - May: 10 days
  - July - December: 0 days

Table 3.1 summarises the expected duration of consecutive days below minimum flow for various return period events[8].

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6 *Stuff article, 7 July 2021, "Investigation into alternative water source from Horowhenua".*

7 *Analysis was undertaken as part of the Options report in Appendix A, hence this timeframe.*

8 *Assuming a Pearson Type 3 statistical distribution.*

Table 3.1: Estimated Consecutive Days Ohau River is Below Minimum Low

Return Period (Average Recurrence Interval, ARI) (Years)	Estimated Consecutive Days below Minimum Flow
5	0
10	2
20	6
50	16
100	26
200	37
500	53
1000	66

Therefore, if the water supply was to be limited such that abstraction was not allowed below minimum flow, the supply could be expected to be interrupted, on average, once every 10-14 years. Interruption of supply could occur for up to 26 days in a row (estimated at a 100 year return period event). The most likely time of the year for minimum flow conditions to occur is mid-late summer and early autumn.

Earthquake Resilience

At present, there is very little stored water and no alternate water supply in an event such as an earthquake that impacts the existing intake and supply. The Options report in Appendix A references the approach of Wellington Water given their close geographical and similar seismic conditions. Wellington Water has identified that, following a major earthquake, the majority of the urban area would be without water for 15-30 days, with some parts being without water for more than 100 days. At present, HDC has no means of being able to provide this or similar level of service post-earthquake.

Climate Change Effects

There is potential for the flow regime of the Ohau River to change from that experienced historically as a result of effects of climate change. Horizons Regional Council has commissioned a "Regional Climate Change Risk Assessment"[9]. This assessment found that:

> *"Precipitation changes have seasonality and spatial variations throughout the region, particularly when looking out to the end of the century. Precipitation is projected to on average decrease on the eastern side of the Ruahine and Tararua ranges in the spring and winter months by mid-century, whilst there is a north- south divide present in summer precipitation changes. Northern areas of the region are projected to experience a 5% increase in summer precipitation, whilst southern areas are projected to have a 5% decrease. Winter rainfall by the end of the century is projected to increase by 20% in the north west of the region, and decrease by 20% in the south east of the region. The north-south divide is no longer present in summer months at the long-term timeframe, and spring rainfall is projected to increase by 5% across majority of the region (NIWA, 2016). Increases in precipitation can lead to the increased frequency and intensity of inland flooding and landslide events. Due to the geography (e.g. vast river networks) and geology (e.g. erodible soils) of the region increased precipitation is likely to exacerbate the impacts from these climate-induced hazard events."*

Projections for the Ohau River, being in the south-west of the region remain unclear. It is most likely that any changes in flow in the Ohau River, particularly over the short term, will be within the natural variation already experienced. This is because the flow regime is controlled by the weather systems

[9] *Tonkin + Taylor Ltd, September 2021, Manawatū-Whanganui Regional Climate Change Risk Assessment.*

and orographic effect of the Tararua Ranges. The climate risks to the District have been identified in the regional assessment as shown in Figure 3.2. This identifies risks to water supplies given the District's dependence on surface water takes.

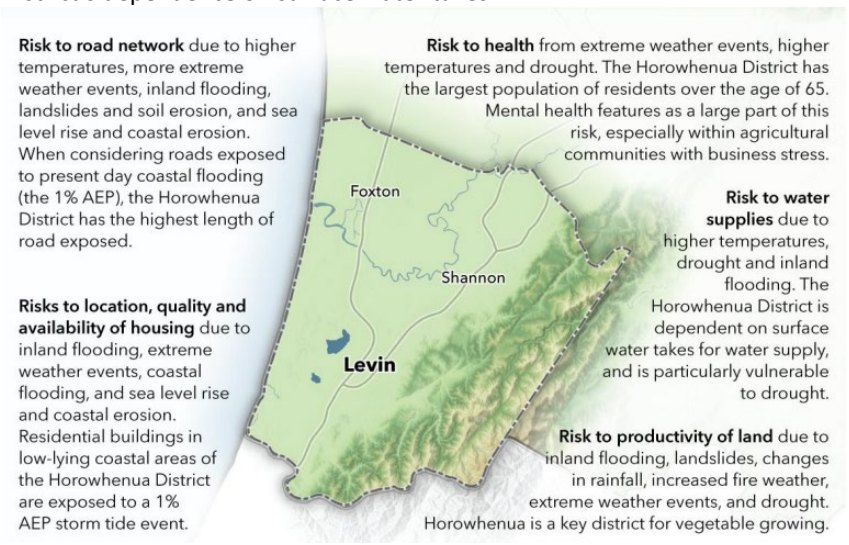


Figure 3.2: Overview of Risks for Horowhenua District
Source: T+T, September 2021, Manawatū-Whanganui Regional Climate Change Risk Assessment

In terms of risks to water supply, the regional risk assessment is shown in Figure 3.3. It also notes that:

> *"Adaptive capacity of water supply sources within the region will rely on the maintenance/enhancement of storage and the ability to manage water demand levels - particularly in areas such as Palmerston North, Ohakune, Feilding and Levin where development and growth is occurring. Targeted interventions such as demand management and behaviour changes could improve water efficiency within the region."*

Hazard	Present	2050	2100	Commentary
Drought	High	High	Extreme	Increased exposure of water supply sources with time, with Tararua district liekly to be the most affected. Sensitivities include reduced flows, over allocation, and reduced water availability and quality. Water restrictions and metering can help reduce the impacts of drought.
Higher temperatures	Low	Moderate	High	sources with time, with Tararua district liekly to be the most affected. Sensitivities include reduced flows, over allocation, and reduced water availability and quality. Water restrictions and metering can help reduce the impacts of drought.
Inland flooding	Low	Moderate	High	Increased exposure on the Manawatū Plains (including Manawatū, Rangitīkei and Whanganui). Flood waters can overwhelm groundwater wells and cause rivers to swell, leading to contamination. Legislation is in place to improve water quality within the region through One Plan and Water Matters.

Figure 3.3: Risks to Water Supply by Hazard as per Regional Climate Change Risk Assessment
Source: Tonkin + Taylor, September 2021

3.1.3 Current Water Demand

Current Community Demand

The community's current water demand is shown in Figure 3.4. This shows the trend in water consumption (as measured by the amount of water which leaves the treatment plant following the treated water storage tanks) as a daily demand since the existing consent commenced. This shows a typical municipal water demand pattern being a base flow in the winter periods, with a seasonal peak in the summer months. The base demand is in the order of 8,000-9,000 m^3/day and the peak summer demand is just over 12,000 m^3/day[10].

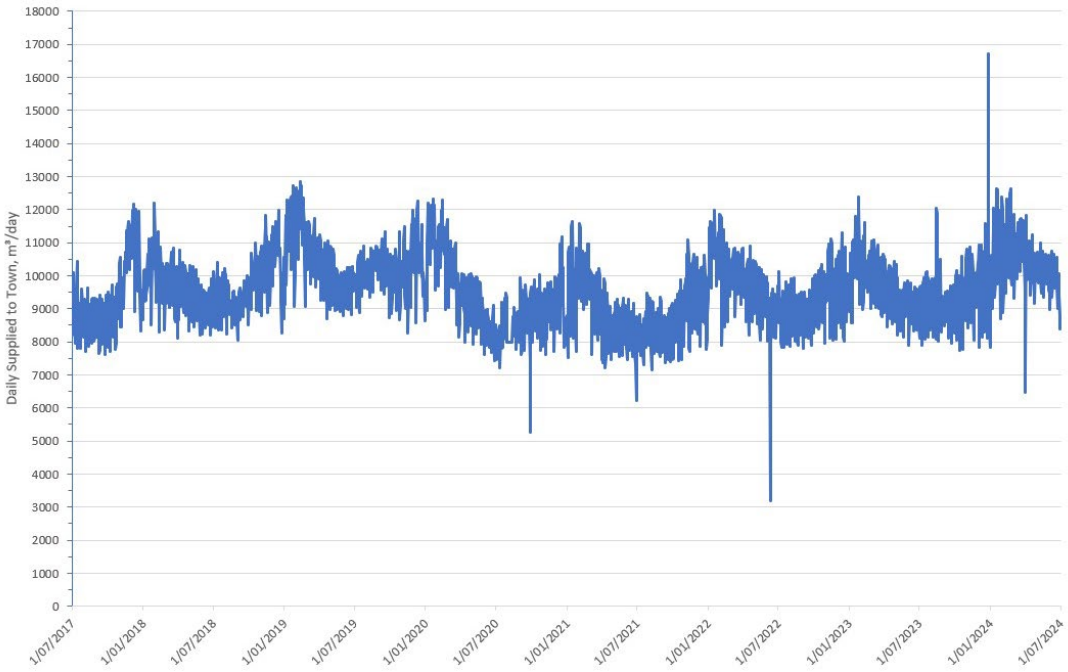


Figure 3.4: Community Water Demand

It must be noted that the water demand shown in Figure 3.4 is different from the amount of water which is abstracted from the river. Figure 3.5 shows the amount of water abstracted from the river over the same time period. This shows that the peak summer abstraction demand is in the order of 13,500-15,000 m^3/day.

[10] *Note that the peak of just under 17,000 m^3/day in late 2023 is considered to be an outlier. Peak abstraction from the river at this time did not exceed the consent limit of 15,000 m^3/day.*

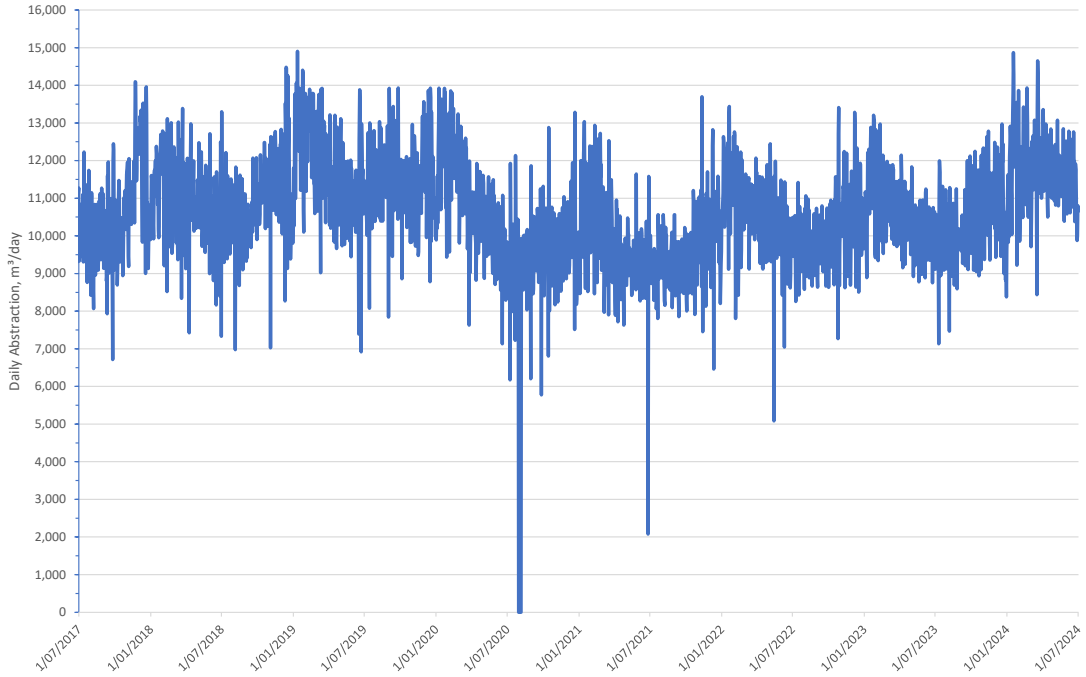


Figure 3.5: Daily Abstraction from River

The difference between the amount of water abstracted from the river and the amount of water delivered to the community is the non-consumptive water which is used in the treatment process, treatment losses (eg backwash water), and variation in abstraction as needed to maintain treated water storage at appropriate levels and maintain fire fighting supplies.

Council's Approach to Ensuring Efficient Use and Managing Water Demand

Council currently operates the system in accordance with the Water Demand Management Plan (WDMP) that was developed under, and required by, the existing resource consent for the abstraction from the Ohau River.

The Water Demand Management Plan[11] defines four trigger levels as a combination of river flow and water demand (refer Table 3.2). The actions relating to each trigger level are defined only within the Water Demand Management Plan, except that the consent requires the water abstraction to be reduced to 13,000 m^3/day at Trigger Level 4.

Table 3.2: Summary of Consent Triggers Levels

Trigger Level	River Flow Trigger (m^3/s)	Trigger Level Conditions in Demand Management Plan	Restrictions Applied (as per Demand Management Plan)	Maximum Abstraction
n/a	> 2.5	River Flow >2.5 m^3/s Demand < 10,000 m^3/day	None - no restrictions	15,000 m^3/day
1	1.5-2.5	River Flow 1.5-2.5 m^3/s Demand > 10,000 m^3/day	Time of use restrictions on garden irrigation; handheld irrigation allowed.	

11 *Version 7, updated July 2022.*

Trigger Level	River Flow Trigger (m^3/s)	Trigger Level Conditions in Demand Management Plan	Restrictions Applied (as per Demand Management Plan)	Maximum Abstraction
2	1.0-1.5	River Flow 1.0-1.5 m^3/s Demand >11,000 m^3/day	Increased restrictions on outdoor use, including alternate day use. No hosing of paved areas. Public spaces not to be irrigated from Levin Water supply	
3	0.82-1.0	River Flow 0.82-1.0 m^3/s Demand > 12,000 m^3/day	Increased restrictions on outdoor use including alternate day hand held hosing restrictions. No garden sprinklers or soak hoses allowed. Filling of pools restricted.	
4	<0.82 (Minimum flow as defined in the One Plan)	River Flow < 0.82 m^3/s	No outdoor use. Fountains not to operate. Restrictions on commercial outdoor use unless expressly approved by Council.	13,000 m^3/day

The demand management actions implemented by Council are based on a combination of communication and education programmes, incentives, regulation and internal (Council network) efficiency improvements. It relies heavily on behavioural change by consumers in response to water restrictions initiated by Council.

The current resource consent requires that the system be managed to ensure that leakage is less than 284 litres/connection/day. This target was required to have been achieved by June 2020 and to thereafter be achieved throughout the term of the consent.

In considering network efficiency and leakage, the Infrastructure Leakage Index or ILI is a key measure that enables benchmarking across supplies (Figure 3.6). As defined in Taumata Arowai's[12] 'Drinking Water Network, Environmental Performance Measures and Guidance Material' document:

> *"Infrastructure Leakage Index (ILI) is the non-dimensional ratio of Current Annual Real Losses (CARL) to Unavoidable Annual Real Losses (UARL). The ILI measures how effectively infrastructure activities (speed and quality of repairs, active leakage control and pipe materials management) are being managed at current operating pressure."*

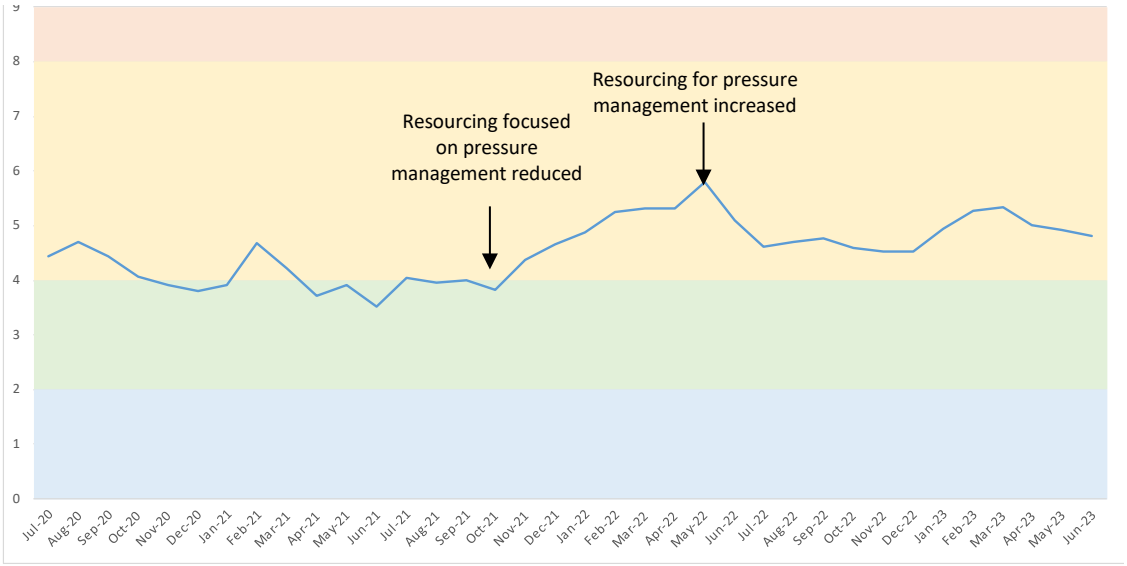
In addition to the leakage target in the consent, Council has adopted, in its Long Term Plan, a performance target of ILI in Band B (being an ILI of between 2 and 4), and a per capita usage target of 300 L/person/day.

Council actively monitors and assesses the leakage per connection (based on measured minimum night flows, with an allowance for actual night-time usage) and ILI on a monthly basis (Figure 3.6). Council is required to report this information to Taumata Arowai on an annual basis, in accordance with the Network Environmental Performance Measures under Section 146 of the Water Services Act.

The leakage target set in the current consent (284 l/connection/day) was derived from an ILI of 3.0. Since that time, Council has implemented a programme of active pressure management across the network and the system now operates at an overall lower pressure. The methodology for determining ILI, which is considered a more appropriate benchmark for assessing network performance, depends on network pressures. The leakage target in the consent of 284 l/connection/day now requires an ILI

[12] *Taumata Arowai is the drinking water services regulator for Aotearoa.*

of 2.73. Figure 3.6 shows the ILI for the system since July 2020. This application proposes that the current consented benchmarks for leakage are replaced with a requirement to set targets in the Water Demand Management Plan and to provide information and benchmarking on performance consistent with that required to be reported to Taumata Arowai as drinking water regulator.



ILI range	BAND	General description of Real Loss Management Performance Categories for Developed and Developing Countries
Less than 2	A	Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement
2 to < 4	B	Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance
4 to < 8	C	Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
8 or more	D	Very inefficient use of resources; leakage reduction programs imperative and high priority

Figure 3.6: Network Performance (ILI) for 2020-2023 Water Year

The current performance of the system does not meet the Council's Long Term Plan target of Band B for ILI, nor does it meet the target per connection leakage rate stated in the consent, nor the ILI of 3.0 from which that leakage rate is derived.

Figure 3.6 shows a period between late 2021 and mid 2022 when internal resourcing on leak detection was reduced and the impact this had on the ILI. Since resourcing was reinstated there has been a reduction and steading of the ILI, however there was a further increase in early 2023 which has now been trending down again. Council officers responsible for this work investigated the increase once it was detected and narrowed down to a couple of zones within the network where increasing leak detection efforts are now being concentrated. Figure 3.6 shows that the issue of network management and leakage control is one which requires consistent and ongoing effort.

Council has a programme of actions planned for addressing water efficiency and water demand and ensuring that water is used efficiently and effectively. This is a work in progress and, given that addressing water leakage requires a concerted effort and significant investment in pipe repair and approvals, needs to be undertaken in a timeframe that is achievable in terms of resourcing to complete the work and also from a funding perspective.

A significant change which Council has approved and funded is the introduction of universal water metering and charging for excess water use across the District. Council is in the process of installing smart-water meters on each connection to increase understanding of the amount of water consumed and also to assist to address leakage within the network and from consumer-side supply lines. This meter roll out is expected to be completed in 2025.

A comprehensive review and update of the WDMP is included as part of this proposal. This is discussed further in Section 4.1.

3.1.4 Projected Future Water Demand

The future water demand projections have been detailed in the options report included in Appendix A. The following provides a summary of those projections[13].

Population Projections

Horowhenua District is experiencing a period of rapid growth which is expected to continue. Since 2014, the district has experienced a growth rate of 2% per annum, with the June 2021 population estimated at 36,708. This growth rate significantly exceeds that assumed when the existing water supply consent was sought. When the application for the current water supply consent was lodged in 2014, the growth projection was only 2% total over the next 50 years (average growth rate of 0.04% per annum). At the time of the hearing, the growth projection had increased, but only to 0.4% per annum[14].

Council commissioned Sense Partners Ltd to advise on projected economic and population growth for the District. In their May 2020 Projections Update report[15], the District was projected to grow more quickly than the national average, quicker than the average of the District over the past 10 years, and substantially more quickly than previous projections. The projected population median and 95th percentile growth figures are given in Table 3.3.

Table 3.3: District Population Projections
(Sense Partners Ltd, May 2020)

Year	Median Growth		95th Projection	
	Per annum	Total population	Per annum	Total population
2019		34,956		34,956
2029	1.8%	41,896	2.6%	44,968
2039	1.2%	47,006	2.8%	59,010
2049	1.0%	51,862	3.0%	79,243
2059	0.7%	55,626	2.9%	105,044
2069	0.6%	59,172	2.3%	131,741

[13] *Note that these projections are drawn from the Water Supply Augmentation Operational Framework report (options assessment) included in Appendix A which was completed in March 2023, which forms the basis of the decision to proceed with this proposal. The projections have not been updated since then as they reflect the growth projections that have informed the proposal design.*

[14] *As reported in paragraphs 34-36 of evidence of Kim Fraser (Allocation Forecast), Beca Ltd, on behalf of Horowhenua District Council at the resource consent hearing for the existing water permit; May 2015.*

[15] *Sense Partners Ltd, May 2020, Horowhenua Socio-economic Projections Summary and Methods - Projections Update Report.*

For infrastructure planning purposes, the Council adopted the 95th percentile projections set out above. This is summarised in the Council's Infrastructure Strategy 2021 - 2051:

> *"Moving forward our district's population is projected to grow at a rate of; 2.6% per annum from 2021 until 2031, increasing to 2.9% per annum until 2051. This means our population will increase to over 62,000 by 2041 and over 80,000 by 2051.*
>
> *The increase in population means the number of houses throughout the district will more than double by 2051. The current number of houses is estimated to be 16,606 as of June 2021. This is anticipated to grow by 21,145 to 37,751 by 2051."*

The 95th percentile projections may be considered to be an extreme high scenario and therefore the options assessment in Appendix A also considered the likely future demand under the median growth projections. Council's most recent Infrastructure Strategy (2024 – 2044) states that: *"Growth forecasts have pulled back since 2021 lowering forecast population and household numbers from 2021 estimates, but Horowhenua is forecast to continue as the fastest growing district in the Manawatu-Whanganui region, and to grow strongly alongside the greater Wellington Region councils. Our district's population is projected to grow at a rate of 1.5% per annum from 2023 until 2030, increasing to 2.1% per annum until 2044. This means our population will increase to over 54,000 by 2044 and over 66,000 by 2054."* This places the latest projections somewhere between the median and 95th percentile projections on which the options assessment report is based.

In Levin rapid growth is occurring with Council completing rezoning of the Taraika Plan Change area to provide for new residential development. Taraika is located to the east of Levin and includes 420 ha which is now available for residential land use, together with some commercial and public areas to create a mixed-use urban area. Once fully developed, the Taraika area will result in at least 3,500 additional homes. The Plan Change is now fully operative.

This application seeks to secure sufficient water to enable it to meet the reasonable community needs for the projected population, noting that the Levin water supply currently provides water to approximately 60% of the District.

Basis of Projected Water Demand

The water demand projections adopt the growth projection rates and apply these to Levin's current water demand to develop projected water demand requirements for consenting purposes. This assumes that water demand is directly correlated with population growth (i.e., that per capita water demand does not vary). This is considered an appropriate basis for projections for purpose of infrastructure planning and consenting. In reality, the per capita water demand may vary if there is a change in the mix of residential to non-residential water users; or if water consumption patterns change or significant water efficiency improvements are made.

In terms of the mix of residential and non-residential water use, Council has some control over this factor via their Water Supply Bylaw and how they consider and approve applications for non-residential water connections. Any efficiency improvements will result in the actual water demand being below (less than) that projected. However, there is no certainty as to the quantum of efficiency or water conservation improvements that can be achieved nor how quickly these can be achieved. Therefore, the projections below are considered appropriate for the purposes of consenting given the statutory obligation to provide the water service.

The projections have been derived from measured water demand for the community over the last five years. This is the demand data (i.e. the amount of water supplied to the community as measured after the treated water storage reservoir) and does not include water abstracted on a non-consumptive basis (as allowed for in the consent to provide for backwashing in the treatment process). It also does not include any additional water abstracted at higher rates than the community demand, e.g. for purposes of filling the treated water storage.

Projected Peak Demand

Figure 3.7 shows the projected peak water demand, being the maximum daily demand required by the community each year. This is projected using data from recent years, noting that water restrictions have generally been in place when the peak day demand was recorded. Figure 3.7 therefore shows the projected peak daily demand assuming the current water restriction policy continues to be implemented as a minimum.

Given that treated water storage is only 1-day's peak demand supply, **the peak daily demand projections represent the water allocation required if there is no bulk storage in the system. This is the situation for the current system.**

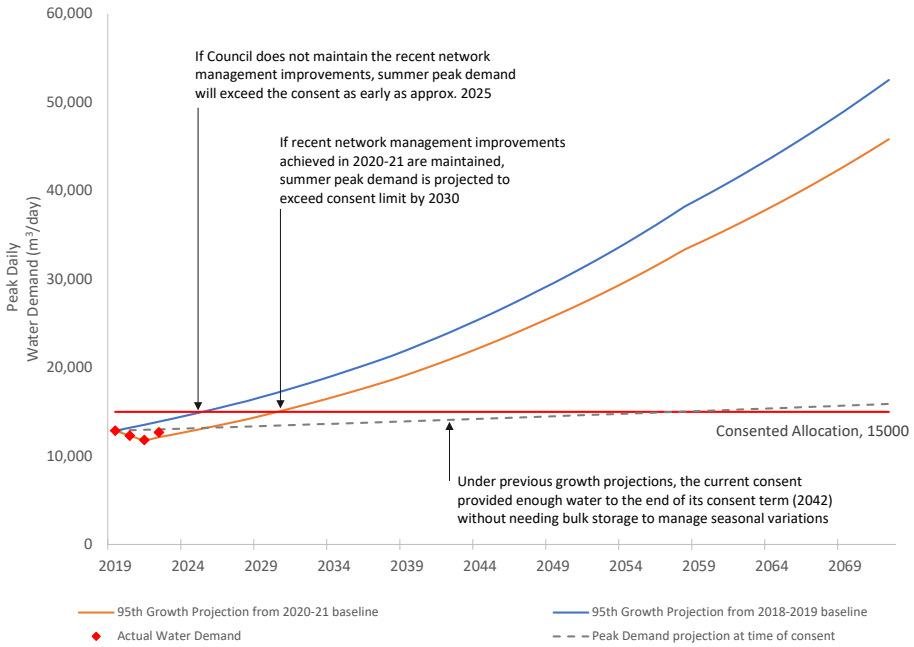


Figure 3.7: Peak Day Projections
Note: Peak day projection is indicative of resource consent allocation required if there is no bulk storage in the system; also indicative of treatment plant capacity required. Figure assumes 95th percentile growth projection and similar per capita demand as existing.

The above projection shows that the existing consent does not provide sufficient water to meet the community's needs beyond 2030. It also shows the importance of maintaining appropriate pressure management and addressing leakage in the system.

Projected Average Demand

If bulk storage is provided (such as that proposed in this application), water allocation requirements can be based on average water demand rather than peak water demand (i.e., by filling up the storage when demand is less than average and drawing from the reservoir when demand is above average). The following provides an analysis of demand projections based on average water demand.

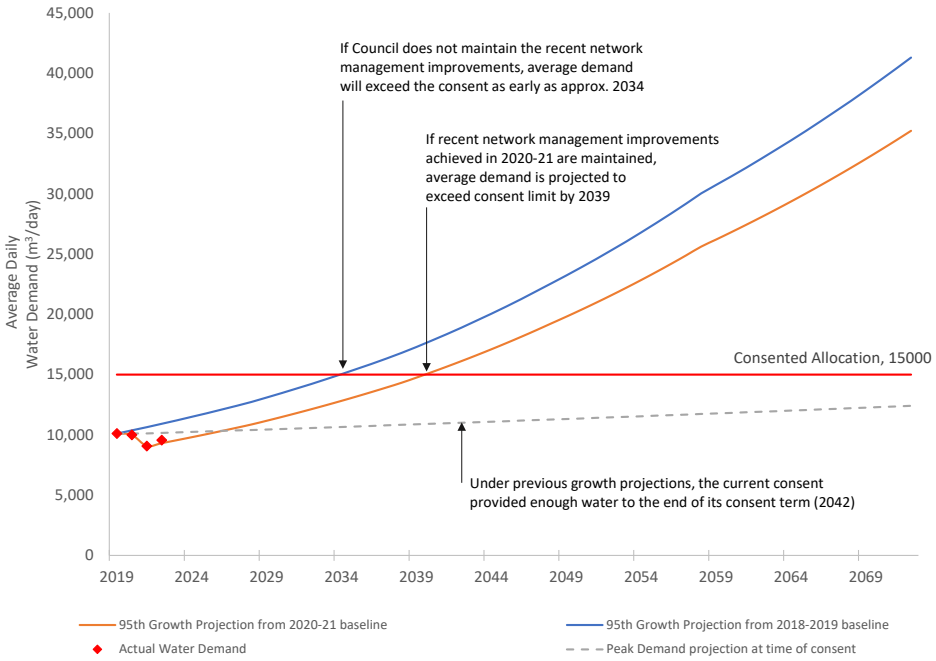


Figure 3.8: Average Day Demand Growth Projections

The above analysis shows that the existing consent does not provide sufficient water to meet the community's needs beyond 2039 even if raw water bulk storage is added to the supply system. For this reason, the Council is also seeking a supplementary allocation from the Ohau River.

Annual Water Demand

Understanding the annual water demand is necessary for determining the size of reservoir required and the Supplementary Allocation required.

Figure 3.9 shows projected water demand on an annual basis. This shows that, based on the projections that were available at the time the existing consent was determined, the consent provides sufficient water to meet the 50-year projected demand. However, because of the increased growth rates which have been experienced, and are projected to continue, the existing allocation is insufficient to meet the community's water demand over a 50-year planning timeframe.

Figure 3.9 includes two "available allocation" lines for comparison. The solid red line assumes that the consented 15,000 m^3/day is available to be abstracted 365 days per year. A 5-year return period event is likely to result in no days when river abstraction is constrained during low flow conditions. The solid red line in Figure 3.9 represents that scenario.

The dashed red line assumes that this is not the case, and the ability to abstract the full consented allocation is assumed (hypothetically) to be reduced as follows:

- For 16 days per year, water abstraction must be reduced because the river is below its minimum flow. This represents an estimated 50-year return period event. For planning purposes, the dashed red line in Figure 3.9 assumes that there is no abstraction when the river is below minimum flow.
- For up to 10 days per year, water abstraction must stop because of high turbidity in the river. Note that this is a conservative estimate and is highly variable depending on actual weather patterns and catchment conditions.

No analysis has been undertaken of the risk of having a year where both the above scenarios occur. The dashed red line in Figure 3.9 is therefore a conservative scenario and only indicative of what may occur. It represents 26 days of no abstraction from the river for some reason. This is also equivalent of likely maximum consecutive days the river is below minimum flow in a 100-year return period event.

The above assumptions are indicative for planning purposes only. Natural flow variations are such that each year may have more or fewer restricted abstraction days than assumed above.

The assumptions above indicate a total abstraction approximately 7% less than if the existing resource consent was exercised fully.

Figure 3.9 shows that, depending on the degree to which abstraction from the river is constrained (at either low or high flows) and the demand projection assumed, there is a shortfall of 7.8 - 10.0 million m^3/year between projected community demand and the allocation available under the Council's existing consent, assuming a 50-year planning timeframe. This planning timeframe is longer than required under the Council's Infrastructure Strategy and the NPSUD, however, it reflects the fact that assets such as a water storage reservoir and the connecting pipeline to the treatment plant have typical asset lives of at least 80-100 years.

If a 30-year planning horizon is adopted as per the Infrastructure Strategy and NPSUD definition of long-term, there is a shortfall in the order of 2.6-4.6 million m^3/year between projected community demand and the allocation available under the Council's existing consent.

At the 35 year consent term sought, there is a shortfall of 3.9 - 6.1 million m^3/year between projected community demand and the allocation available under the Council's existing consent.

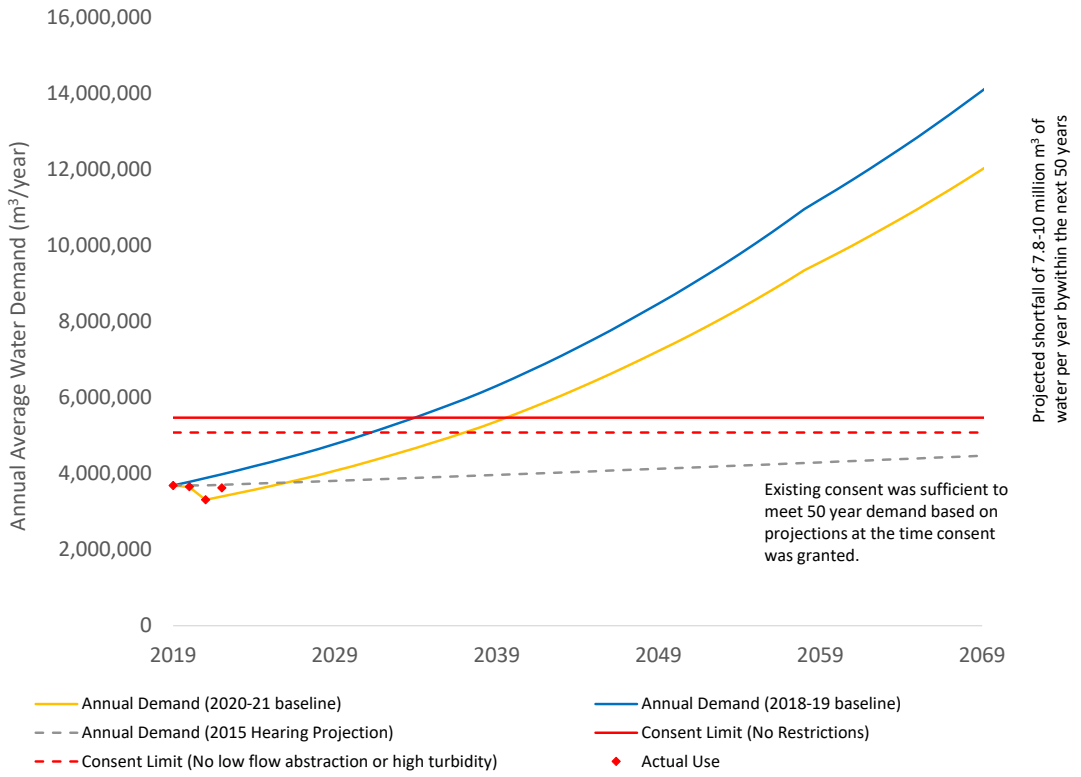


Figure 3.9: Annual Water Demand Projections

3.2 Description of Receiving Environment

The following describes the environment and existing sites where the proposed activities are to occur. In particular, the Ohau River from which the water is to be abstracted; the proposed reservoir intake site including the river bed and riparian area; the proposed reservoir site; and the pipe bridge site.

3.2.1 Ohau River

The Ohau River originates in the Tararua Forest and generally flows in a westerly direction towards the Tasman Sea. Approximately 800 m downstream of the proposed reservoir intake site, the Ohau is joined by the Makahika Stream. Three other tributaries join the Ohau River between the Makahika Confluence and the existing intake site, the largest of these being the Makaretu Stream.

The Ohau River is a significant water body within the Horowhenua District and is of cultural significance to iwi and hapū. The Ohau River is a taonga of cultural, material and spiritual significance and has been identified as a source of spiritual sustenance, mahinga kai and swimming and camping.

The hydrology of the River is described in the Hydrology Assessment report in Appendix D.

One Plan Water Management Areas and Values

Under the Regional Council's One Plan, the Ohau River and its catchment make up the Ohau water management area (Ohau_1) which comprises two sub-areas, being the Upper Ohau (Ohau_1a) and Lower Ohau (Ohau_1b). The separation point between the two sub-areas is the Rongomatane Gauging site approximately four kilometres downstream of the proposed reservoir intake site and 800 m upstream of the existing intake site.

In accordance with RP-SCHED2 of the One Plan, the Ohau River is to be managed to provide for the following values:

- Area Wide Values (these apply to the entire area):
  - Life supporting Capacity: Upland Hard Sedimentary for the Upper Ohau (Ohau_1a) and Hill Mixed for the Lower Ohau (Ohau_1b)
  - Aesthetics
  - Contact Recreation
  - Mauri
  - Industrial Abstraction
  - Irrigation
  - Stockwater
  - Existing Infrastructure
  - Capacity to Assimilate Pollution
- Site or Reach Specific Values. These apply to specific sites or reaches of the River as defined in RP-SCHED2 and listed below:
  - Natural State. This value only applies to the portion of the Ohau River which flows within the Department of Conservation estate. The proposed abstraction point is located approximately one kilometre downstream of the Conservation estate and therefore this value does not apply to the area of the proposed works nor any of the abstraction sites.
  - Site of Significance - Aquatic. This applies to the following parts of the Ohau and its tributaries:
    - Waiti Stream which is valued for Redfin Bully. The Waiti Stream is in the Upper Ohau and is a tributary of the Makahika Stream. It is in a different part of the catchment and upstream of the abstractions and therefore its flow regime or other attributes is not in any way affected by any of the activities which are subject to this consent.

  - The main stem of the Ohau River from the confluence of the Ohau River and Makahika Stream to approximately 600 m downstream of the existing intake site is valued for **redfin bully, bluegill bully and banded kokopu**. A further section of the Ohau River just downstream of Kimberley Reserve to approximately 1 km downstream of SH1 is also valued for Redfin Bully The abstraction sought has the potential to affect the hydrology and habitat in these areas. These effects are discussed in Section 9.3. The proposed reservoir intake site is also upstream of this reach of river. The construction will need to be managed to ensure sedimentation effects do not occur downstream of the proposed works so that this value is not affected in the main stem of the river.
  - The Makorokio Stream, a tributary of the lower Ohau River is also valued for redfin bully, lamprey and shortjaw kokopu. No works are proposed on this Stream and the Stream's hydrology is not affected by the proposed abstraction.
- Sites of Significance - Riparian. This value applies only to the lower Ohau River and the reach identified is from approximately 1 km upstream of the SH1 bridge to the Coastal Marine Area boundary. The riparian habitat to be protected is that of gravel and sand for dotterel, and mud/silt habitat and estuarine roosts for waders. The temporary abstraction for the Ō2NL construction is in this reach.
- Inanga Spawning. This value also applies only to the lower Ohau River and the reach identified is the most downstream 3km prior to the coastal area. There are no works proposed in this reach. The outlet watercourse from Lake Waitaha is also valued for Inanga Spawning. This watercourse is not affected by any of the proposed activities.
- Amenity Value. This value applies only to the lower Ohau River and the sites identified are Kimberley Reserve, Kirkcaldies Bridge Reserve, Gladstone Reserve and Parikawau Reserve.
- Whitebait Migration. This value applies only to the lower Ohau River and the reaches identified are the Lake Waitaha outlet watercourse and the Ohau River downstream of the Lake Waitaha watercourse confluence, being the furthermost downstream extent (approximately 3km) of the River towards the coast.
- Trout Fishery - Other (i.e. not nationally or regionally significant). This value applies to both the lower and upper Ohau River from the coastal marine area boundary to the source of the Ohau including the Makahika Stream and tributaries. The proposed activities occur within this reach.
- Trout Spawning. This value applies to both the lower and upper Ohau River. In the upper Ohau it applies to the Makahika Stream and its tributaries and to the Makaretu Stream and its tributaries, but not to the main stem of the Ohau. In the lower Ohau it applies to the Makorokio Stream and its tributaries but not to the main stem of the Ohau. None of the proposed activities affect the reaches to which the trout spawning value applies.
- Water Supply. This value applies to the Ohau River above the existing intake site. It is set to protect the ability to abstract water and to protect the quality of the water for drinking water purposes because of the Levin Water Supply. The activities covered by this application are provided for by this value.
- Domestic Food Supply. This value applies to both the lower and upper Ohau River throughout the catchment.
- Flood Control and Drainage. This value applies to both the lower and upper Ohau River. The main stem of the Ohau River is valued for Flood Control and Drainage from the confluence with the Makahika Stream to the coastal marine area boundary. In the lower Ohau River several tributaries also have this value.

The effect of the proposal on these values, where relevant, is assessed in Section 9.7.

One Plan Allocation Framework

The One Plan (combined Regional Policy Statement and Regional Plan) establishes an allocation framework consisting of the following elements:

- A minimum flow to be maintained in the River. This is set to protect the river's life supporting capacity and to provide for the water management values identified above (as per Objective LF-FW-O5 (1)(a) of the One Plan). In general, abstractions are required to cease when the River is below the minimum flow except that, in accordance with Policy LF-FW-P21, Essential Uses may continue provided there is a reduction in abstraction. The existing Levin Water supply consent enables abstraction to occur at a reduced rate of 13,000 m^3/day when the river is below minimum flow. The proposal will enable Council to avoid exercise of this abstraction except in exceptional circumstances as detailed in Section 4.2. **The minimum flow for the Ohau River is defined in the One Plan 820 L/s at the Rongomatane Gauging site**.
- A core allocation is set which is the total amount of water which can be taken above minimum flow whilst still providing for the water management values of the water body (as evidenced by the fact that applications to take from the core allocation are regulated as Controlled Activities under Rule LF-TUD-R44 of the One Plan). **For the Ohau River, the core allocation is 24,192 m^3/day as defined in RP-SCHED3. It is understood that this core allocation is fully allocated. HDC holds core allocation consents equating to 15,409 m^3/day or 64% of the total allocation**.
- **A supplementary allocation which can only be taken when the river is above median flow and which, in total is not to exceed 10% of the actual flow in the river at the time of abstraction**. The purpose of the supplementary allocation is to enable water to be taken at higher flows when the likely effects on the river will be less than minor. This enables water harvesting and storage schemes such as that proposed in this application.

3.2.2 Proposed Reservoir Intake & Spillway Discharge Site

The proposed reservoir intake site is located within and adjacent to the Ohau River bed as shown in Figure 3.10 including its location in relation to the other proposed activities and existing intake site.

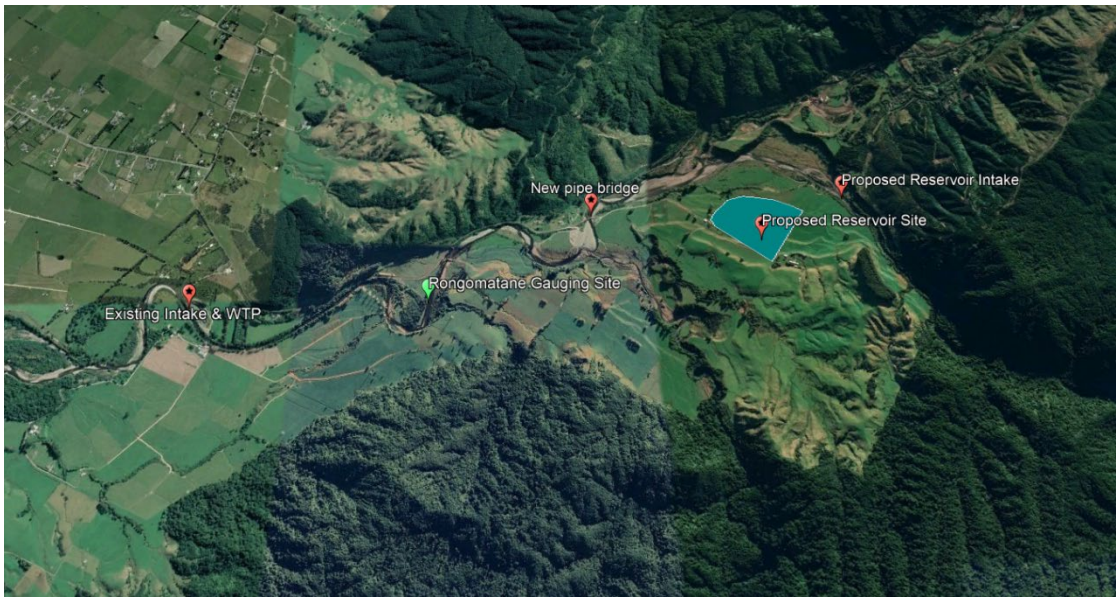


Figure 3.10: Location of Proposed Activities

The riverbed in this area is located within a property title described as Lot 1 DP 12594, at 116 Poads Road.

The proposed reservoir will include a spillway which, in infrequent circumstances, will discharge water back into the Ohau River. This activity is described in Section 4.3. The spillway will discharge water to the Ohau River immediately downstream of the intake location.

The habitat and ecology at this site, including the riparian vegetation which will be disturbed by the proposed works is described in the ecological assessment report included in Appendix G. It describes it as follows:

> *This section of river provides high-quality habitat for indigenous fish and macroinvertebrates, with riffles being a particularly productive habitat type within large river systems. Its position within the wider catchment means that it is also critical to maintain connectivity through this area, to allow the natural migration and movement of fish and macroinvertebrates in both upstream and downstream directions.*
>
> *The section of the true left bank along which the erosion protection armouring will be installed …is steep and covered in dense tutu (Coriaria arborea var. arborea), with occasional clumps of toetoe (Austroderia fulvida) ... Exotic pampas grass (Cortaderia selloana) is also present along the river margins. The understorey is a mixture of indigenous species including Coprosma spp., māhoe (Melicytus ramiflorus), and wheki (Dicksonia squarrosa) …*
>
> *No rare or threatened indigenous vegetation was observed during the site visit, with all indigenous species being widespread and common. Vegetation in the proposed impact area is therefore of moderate ecological value.*

Figure 3.11 shows the river in this location.



Figure 3.11: River at Proposed Intake Site (looking upstream)

There is a resource consent for gravel extraction which applies at and downstream of this location. That consent, ATH-2013014957.00, is to extract up to 6000 cubic metres of gravel at Hoggs Road and 10,000 cubic metres at Gladstone Road. It has expired, however, a renewal application has been lodged and is on hold. The expired consent remains active under s124 of the RMA. The proposed activities do not affect the ability for this gravel extraction consent to be exercised.

The site is zoned Rural under the Horowhenua District Council's District Plan and subject to a 200 m aggregate extraction buffer overlay.

3.2.3 Proposed Reservoir Site

The proposed reservoir site is located at the end of Poads Road as shown in Figure 3.10. The site is zoned Rural under the Horowhenua District Council's District Plan and part of the site is subject to a 200 m aggregate extraction buffer overlay.

An ecological assessment of the proposed reservoir site, including the lower floodplain terrace on the property, has been undertaken to assess the ecological values of the site and to determine if there are any natural inland wetland areas that would require a resource consent under the National Environmental Standards for Freshwater (NES-FW).

The ecological assessment identified five sites which required assessment and delineation to assess whether they are to be classified as a natural inland wetland under the NES-FW. These are shown in Figure 3.12, replicated from the ecological assessment in Appendix H.

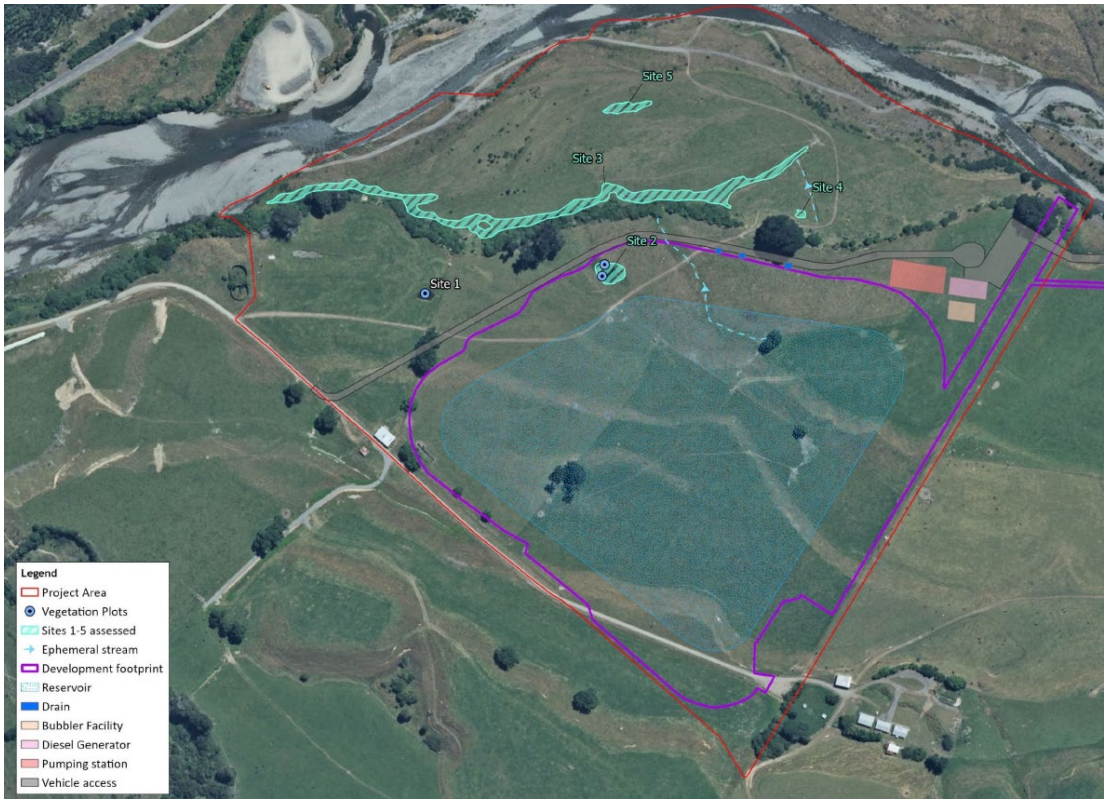


Figure 3.12: Areas Subject to Natural Inland Wetland Assessment
Source: Figure 1 of Wildlands report, Appendix H of this AEE.

These sites were assessed in accordance with the New Zealand vegetation tool for wetland delineation (Clarkson, 2013), being the standard methodology to assess the presence of plants adapted to wet conditions. The assessment methodology is detailed in the ecological assessment report in Appendix H. Wildlands also assessed if these sites would be classified as rare, threatened or at-risk habitats under the Regional Council's One Plan.

As shown in Figure 3.12, two sites were identified on the upper terraces where the reservoir is to be constructed, and three on the lower floodplain terrace where the cultural offset mitigation is to be undertaken (refer Section 4.6).

Possible Wetland Sites on Upper Terrace (Reservoir Site)

- Site 1: This site is outside of the reservoir footprint and also not affected by the access road and ancillary infrastructure proposed. Site 1 is not considered to be a natural inland wetland as it meets the pasture exclusion criteria. As it is not a wetland, site 1 is also not considered to be a rare, threatened or at-risk habitat.
- Site 2 is within the reservoir footprint and will be affected by the reservoir construction. It is described as:

  a small open-water shallow depression covering an area of c.400 m^2, with a narrow fringe of wetland vegetation that includes jointed rush (Juncus articulaus, OBL), water purslane (Ludwigia palustris, OBL) with abundant Yorkshire fog (Holcus lanatus, FAC), Mercer grass (Paspalum distichum, FACW), creeping bent (Agrostis stolonifera, FACW) and occasional patches of (Persicaria hydropiper, FACW), creeping buttercup (Ranunculus repens, FAC) sweet vernal (Anthoxanthum odoratum, FACU), and white clover (Trifolium repens, FACU).

  This site was assessed by Wildlands via two representative 2 x 2 metre vegetation plots in the narrow strip of vegetation surrounding the small area of open water. One of these plots was assessed as qualifying the site to be a natural inland wetland. The second plot met the pasture exclusion criteria of the NES-FW and was assessed as not qualifying the site to be a natural inland wetland.

  Overall, Wildlands assessment is that "*This site could be classified as a wetland but it is a very marginal classification*". Wildlands noted that "*although, technically, this site could qualify as a wetland, albeit marginally, in terms of the NPS-FM, it is highly modified, the vegetation is predominantly exotic, and it is not ecologically significant. It also has little potential for ecological restoration*." It was further assessed by Wildlands as not being a rare, threatened or at-risk habitat under the One Plan.

  Adopting a precautionary approach, this application has been prepared on the basis of this site being a Natural Inland Wetland under the NES-FW.



Figure 3.13: Site 2 within the Reservoir Footprint - Marginal Classification as a Natural Inland Wetland

Possible Wetland Sites on Lower Floodplain Terrace (Cultural Offset Management Area)

- Site 3 is a small watercourse which follows the toe of the slope from the upper terrace and connects with the Ohau River at the downstream end of the property. It has been assessed as a Natural Inland Wetland under the NES-FW, and as a Rare habitat under the One Plan RP-SCHED6.

This is an area which is proposed for active restoration under the Cultural Offset Management Plan (refer Section 4.6).

- Site 4 is a very small area (approximately 50 m^2) in a shallow depression. It was assessed to be a Natural Inland Wetland under the NES-FW, but does not qualify as a rare, threatened or at-risk habitat under the One Plan RP-SCHED6. Wildlands state that "*in isolation, it has little potential for ecological restoration*". This area is part of the active restoration area of the Cultural Offset Management Plan.
- Site 5 is approximately 276 m^2 formed in a shallow depression on the lower terrace. It is also considered to be a Natural Inland Wetland, but does not qualify as a rare, threatened or at-risk habitat under the One Plan RP-SCHED6. This area is part of the passive restoration area of the Cultural Offset Management Plan.

The above sites, including the plant species identified within each site, are discussed in more detail in the ecological assessment report in Appendix H.

Lizard Survey

Wildlands also undertook a lizard survey of the reservoir site (refer Appendix H), given the presence of potential lizard habitat on the site (particularly areas containing rock piles, deep leaf litter, and dense vegetative groundcover). The lizard survey did not find any lizards on the site, and concluded that:

> *If lizards are present, but below detection levels, the most likely undetected species is northern grass skink (Oligosoma polychroma - 'Not Threatened'), which is widespread in the southern North Island and known to be able to persist in disturbed and marginal habitat. However, based on the survey results, there is high confidence that lizards are not present and no further lizard management is necessary at this site.*

3.2.4 Proposed Pipe Bridge

The proposed pipe bridge will be immediately upstream of the existing Poads Road bridge across the Ohau River and within road reserve. The pipe bridge location and general alignment is shown in Figure 3.14.

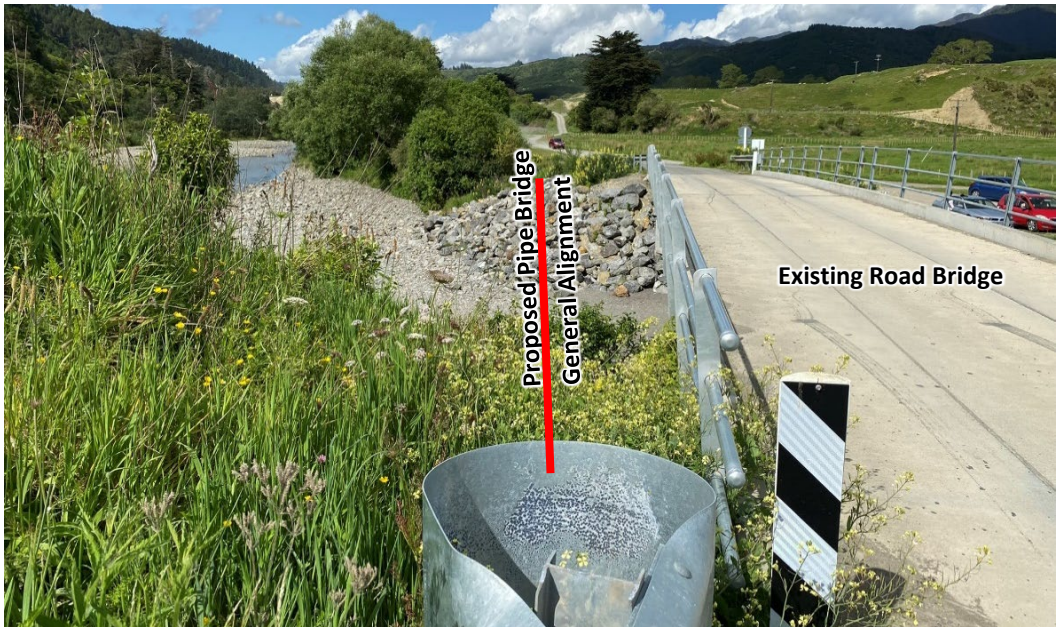


Figure 3.14: Proposed Pipe Bridge General Location

The pipe bridge will replace a previously disused pipe bridge which has only recently been removed from the same alignment. The decommissioned pipe bridge was used to convey water from the historic intake for the Levin Water supply which was constructed in the early 1900s and located upstream of the proposed intake site (refer discussion in Section 6.2.2). The previous pipe bridge is shown in Figure 3.15.



Figure 3.15: Poads Road Previous Road Bridge and River Crossing
(from true left bank looking towards Gladstone Road, Google Street View imagery, November 2019) Pipe bridge has since been removed and road bridge replaced.

3.2.5 Existing Intake Site

The existing intake site's location is shown in Figure 3.10. The existing intake consists of a perforated 750 mm diameter Aluflow Pipe laying parallel to the river flow and extending 66 m downstream and 175 m upstream and laid with the invert approximately 1 m below the river bed. These pipes feed into a central intake chamber from which water is abstracted and fed into the treatment plant.

This application does not include any physical works to be undertaken at this site. The Levin Water supply abstraction will continue at this site as described in Section 4.1.2.

The Council undertake regular maintenance and works in the river bed at this site in order to maintain the ability to abstract from this intake. This bed disturbance is authorised under resource consent ATH-2008010962.02 which authorises "periodic scarifying, flushing, back wash, flood debris removal in the Ohau River for Levin Municipal Water Supply Intake Gallery Operation and Maintenance Purposes". This consent is not subject to this application and will continue to be held by HDC. It expires in May 2043.

3.2.6 Proposed Abstraction Point for Ō2NL Construction Water

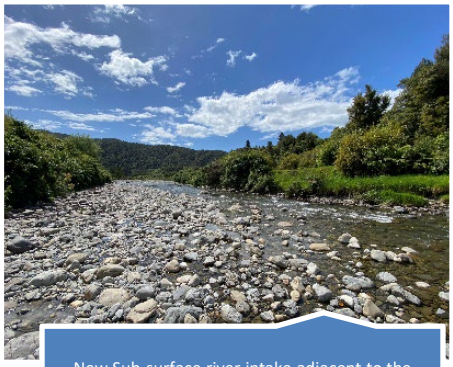
This application includes provision for a short-term abstraction of water from the Ohau River at or near the proposed Ō2NL bridge across the Ohau River, for purposes of supplying construction water for NZTA's Ō2NL Project (refer Section 4.1.2).

The Ohau River from which the water allocation is sought has been described above and in the hydrology assessment report included in Appendix D.

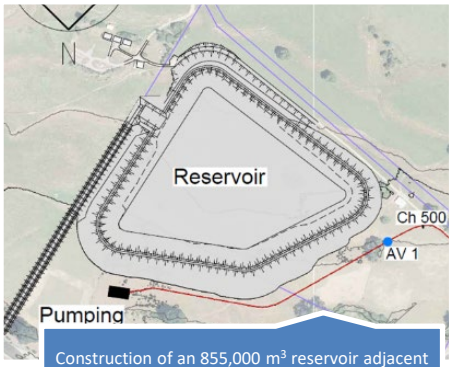
4 DESCRIPTION OF PROPOSED ACTIVITIES

In summary, the proposal is to create a large off-river reservoir adjacent to Poads Road which will improve the resilience of the Levin Water Supply; reduce the effects on the river from abstractions at times of minimum flow; and provide for community growth and wellbeing. Included in the application is all works to enable the construction, operation and maintenance of the reservoir and new reservoir intake, as well as a new water permit encompassing the council's existing core allocation and a new supplementary allocation. A Cultural Offset Management package has been developed via engagement with Muaūpoko Tribal Authority and this application is also seeking the necessary resource consent to enable these cultural offsetting works to be implemented.

The activities which are required to achieve these outcomes, and for which consent is sought, are summarised in Figure 4.1.



New Sub-surface river intake adjacent to the reservoir site including river-edge terracing and infrastructure



Construction of an 855,000 m^3 reservoir adjacent to Poads Road including emergency spillway discharge and ancillary infrastructure (pump house, emergency generator, etc)



Cultural Offsetting and Restoration / Enhancement Programme on lower terrace



New pipeline along the Poads Road - Gladstone Road corridor to convey stored water to the Levin Water Treatment Plant including new pipe bridge across the Ohau River.

New Water Permit to enable existing consented core allocation to be abstracted from either the existing or new (reservoir) intake PLUS new supplementary allocation sought to be able to fill the reservoir when river flows are above median flow.

Short term abstraction from the SH1 bridge site in order to provide construction water for the Ōtaki to North Levin NZTA project subject to overall consented abstraction limits not being exceeded.

Figure 4.1: Overview of Activities

4.1 Water Take

4.1.1 Existing Water Take Consents to be Replaced

HDC currently hold the following water permits to take water from the Ohau River:

- **ATH-1991006011.03 which authorises abstraction at the existing intake (Water Treatment Plant site) of 15,000 m^3/day from the Ohau River,** with the abstraction to reduce to 13,000 m^3/day when the Ohau River is below its minimum flow (820 L/s at Rongomatane Gauging site), plus an additional 750 m^3/day as a non-consumptive take. This water permit expires July 2042.

  This application will replace this existing consent. The proposal is to utilise the existing core allocation that has already been allocated to HDC through to 2042 in a way which provides for a more efficient use of water and infrastructure, by enabling abstraction from either of the existing intake site or the new reservoir intake site. The is described more in Section 4.1.2.

- **ATH-2022205111.01 which authorises abstraction of up to 409 m^3/day at the proposed reservoir intake site** (being the remaining allocation in the Core Allocation limit specified in the One Plan that was available in 2022 as discussed in Section 2.1.1). HDC sought this consent following feasibility assessment of the proposed reservoir when it became clear that the existing core allocation provided under ATH-1191006011.03 was insufficient to meet the community's needs for the projected growth and following the decision to proceed with seeking consent for the proposed reservoir.

  This application will replace consent ATH-2022205111.01 and will see the core allocation from this consent amalgamated with ATH-1991006011.03 into a single new water permit.

HDC therefore enters this consent process with existing consents authorising abstraction of a total of 15,409 m^3/day of the core allocation volume provided in the One Plan, plus an additional 750 m^3/day able to be abstracted for non-consumptive purposes at the WTP intake site.

4.1.2 New Water Permit Sought

The allocation sought via the new water permit is summarised in Figure 4.2 and detailed below.

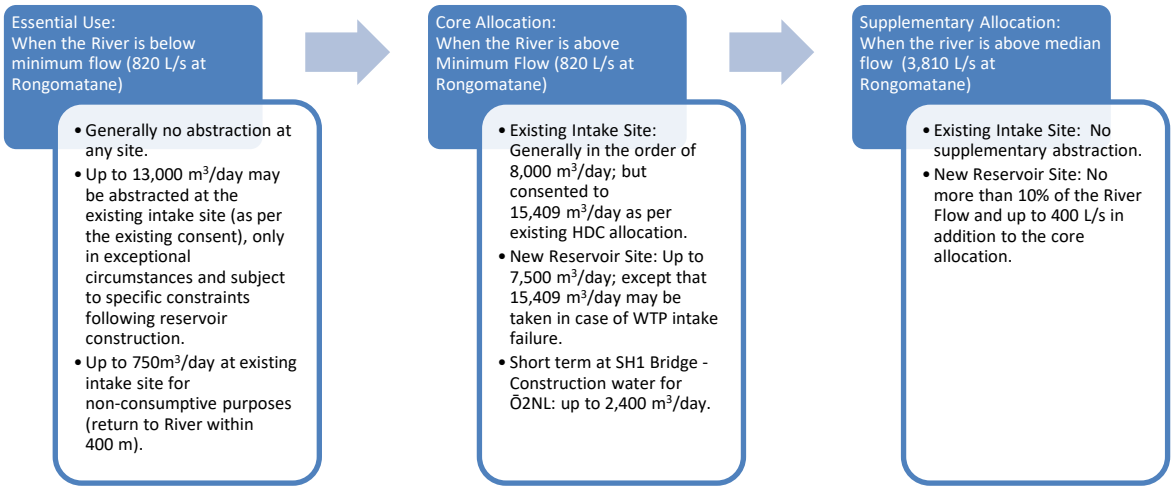


Figure 4.2: Water Allocation Sought

This consent application seeks the following:

Core Allocation

1. **A Core allocation of 15,409 m^3/day able to be taken at any time that the river is above the minimum flow**[16]**.** Consent is sought to enable this water to be taken from any of the following three location points, **subject to the total 15,409 m^3/day not being exceeded at any time**:
   a. **Existing intake (Water Treatment Plant site):**
      - **A consent limit at this site to enable a maximum of 15,409 m^3/day to be abstracted, at a maximum instantaneous rate of 206 L/s (as per the existing consent).** While this is sought as the maximum daily limit from this intake site (which would mean, on that date, the other two intake sites are not utilised), this will not be the normal operating scenario. A consented limit of 15,409 m^3/day from this site is the same as what is already authorised under the existing core allocation consents held by the District Council.
      - Under normal operating scenario (refer Section 4.1.3) abstraction from this site would more likely be in the order of 8,000 m^3/day. This equates to the current winter demand or base demand from the community and is also preferred in terms of enabling the existing intake to operate at its optimum abstraction rate. The intent is that the base demand (less any water drawn from the reservoir to provide for turn-over in the reservoir to maintain stored water quality) is drawn directly from the river at the treatment plant. Overtime, and depending on the rate of growth in the community and the performance of the existing intake, the normal operating abstraction from the existing intake site may increase to match base demand.
      - **As per the existing consent for this intake, a further 750 m^3/day of non-consumptive water may be taken (in addition to the maximum total consumptive take across all three intake sites of 15,409 m^3/day).** The existing consent provides for 750 m^3/day of non-consumptive water to be taken subject to it being returned to the Ohau River within 400 m of the point of take. To enable the ongoing operation of the intake and treatment plant, this non-consumptive take is required to be incorporated into the new water permit.
   b. **New Reservoir Intake site:**
      - **A core allocation consent limit at this site of 7,500 m^3 /day to be abstracted at a maximum abstraction rate of 400 L/s.** This is the total consented limit sought (15,409 m^3/day) less the likely base demand abstraction rate which will be abstracted at the existing treatment plant intake site. The full core allocation is not sought to be available at the reservoir intake site, as there is a smaller river flow at the reservoir intake site compared to the existing treatment plant intake site. Abstracting the full 15,409 m^3/day from the reservoir intake site on a regular basis may have an increased effect on the river, particularly at low flows.
      - In the event of a failure of the existing WTP intake, up to 15,409 m^3/day may be abstracted if necessary to maintain community water supply.
   c. **Temporary Intake for Purposes of Enabling the Construction of NZTA's Ōtaki to North Levin State Highway**. To enable the efficient allocation of water, HDC seek to provide, through this consent, the ability for NZTA to utilise some of the allocation provided to HDC for future growth so that they are able to use this water for purposes of construction of the Ōtaki to North Levin Project (Ō2NL Project). The location of this abstraction point is from the Ohau River immediately upstream and downstream of the proposed Ō2NL bridge, and within the area that has been designated for the State Highway. Water will be abstracted from the

[16] *The river's minimum flow is defined in RP-SCHED3 of the One Plan 0.820 m^3/s at the Rongomatane Gauging site.*

river and stored in water storage ponds[17] which are part of the construction works. Water will then be abstracted from the water storage as necessary to meet the construction project needs.

- Core allocation for this use shall be limited to 2,400 m^3/day and subject to the total daily core allocation abstraction authorised under this consent.
- The average rate of abstraction at this site is 28 L/s
- The maximum rate of abstraction at this site is 50 L/s.
- There shall be no abstraction from this site when the river is below minimum flow.

It is noted that use of water for the Ō2NL Project's construction is not enabled under the existing water permits. This application specifically includes use of water for Ō2NL Project's construction within the activity description to enable the use of water for the construction period. It is considered that enabling use of water for Ō2NL Project's construction via this consent application provides for efficient allocation of water as it provides short-term use for the Ō2NL Project's construction whilst securing medium to long term allocation of water to provide for community growth. Given the allocation status of the Ohau River, not seeking sufficient water for medium to long term community use would put security of supply for the community water use at risk, whilst providing for the Ō2NL Project's construction water within the consent ensures that allocated water is able to be used in the short term.

The use of water for Ō2NL Project's construction is to be limited to the duration of the construction period and will be subject to appropriate conditions of consent, similar to any consent granted directly to NZTA for the same purpose. The current programme is for the Ō2NL Project to be open to traffic by the end of 2029 with completion works continuing through 2030 and likely into 2031. To allow for any unforeseen delays in the construction period, the abstraction is sought for the period from commencement of consent until the end of the 2033 calendar year.

Supplementary Allocation

A supplementary allocation of up to 10% of the river flow above median flow as per Policy LF-FW-P20 of the One Plan is sought to be abstracted at the reservoir intake site.

The supplementary allocation shall only be available at the new reservoir intake site.

The reservoir intake and pumping system has been designed with a sub-surface infiltration gallery arrangement which will convey water via gravity into a pump chamber located outside of the riverbed but within the riparian area. Water will be pumped from that pump chamber to the reservoir. The design flow rate for the pumping system is 400 L/s and it is proposed to ensure that no more than 10% of the river flow is taken when it is above median flow via the imposition of staged daily abstraction limits in addition to that enabled under the core allocation. The following key flow statistics are provided by way of example and it is proposed to work with the consent authority to develop appropriate conditions as the consent progresses. Refer also to the discussion in Section 9.3. The following flow statistics are all based on the estimated naturalised flow regime for the river at the point of intake as per Table 5 of the Hydrology Assessment report in Appendix D (note that river flows specified the bullet points below relate to the estimated flow at the intake site and not at the Rongomatane gauging site):

- At the median flow (1.77 m^3/s), the amount of water which could be taken under the supplementary flow is 177 L/s or just under half of the maximum pump rate. The daily supplementary allocation abstraction at this point would be 15,327 m^3/day and would require the pump to be operating just under half of the time.

[17] *Note: The storage ponds do not form part of this consent application. They are authorised separately under the suite of consents held by NZTA for the Ō2NL Project.*

- At the 25th Flow Exceedance Percentile (FEP) flow of 3.21 m^3/s (ie the flow in the river that is exceeded 25% of the time), the amount of water which can be taken under the supplementary allocation is 27,734 m^3/day, which when the proposed core allocation is also provided for, would require the pump to be operating continuously.
- At flows above the 25th Flow Exceedance Percentile, the Council's abstraction is unable to abstract the full 10% of the river flow above median (at the proposed pump rate) and therefore there is supplementary allocation available for other users above these flows.

It should be noted that this assessment has been derived based on the naturalised flow regime at the intake site as determined by the hydrology assessment included in Appendix D. Further downstream (eg below the confluence with the Makakahi Stream) the river flows are increased and therefore the HDC abstraction does not prevent other users from being able to access supplementary allocation in accordance with the One Plan allocation framework.

Essential Use - Abstraction at or below Minimum Flow in the River

HDC currently has consent through to 2042 to abstract up to 13,000 m^3/day of water from the existing intake site when the river is below minimum flow, as well as a further 750 m^3/day for non-consumptive use. At the moment, the only criteria that needs to be met to be able to abstract below minimum flow is that water demand is managed in accordance with the Water Demand Management Plan (WDMP), and that water restrictions be at Trigger Level 4 as defined in the WDMP.

The ability to abstract below minimum flow is in accordance with Policy LF-FW-P21(4)(d) of the One Plan which provides for essential takes such as public water supplies to continue at times of minimum flow subject to a reduction in abstraction. This also recognises that the Levin Water Supply is nationally and regionally significant infrastructure in accordance with Policy EIT-P1(1)(i) of the One Plan.

Once the reservoir is constructed and operational, HDC will no longer need to be fully reliant on the minimum flow abstraction to meet its obligations under s25 of the Water Services Act to provide sufficient quantity of water to the community. It will, instead, be able to draw water from the reservoir and minimise or avoid the need to abstract from the river.

However, because of those obligations under section 25 of the Water Services Act, and because of the criticality of the water supply to provide for the health needs of the community and its social and economic wellbeing, HDC seeks to retain its existing minimum flow allocation **for use in exceptional circumstances**. Such emergency conditions may include extended drought periods lasting beyond the ability to meet supply from the reservoir, or reservoir supply pipeline failures occurring at a time of minimum flow in the river.

The consent therefore seeks to retain the ability to abstract up to 13,000 m^3/day from the river at the existing WTP intake site when it is below minimum flow as per the existing consent, but with the addition of more stringent conditions as to when this can be exercised. In addition, the 750 m^3/day non-consumptive water take (required to maintain efficacy of the treatment process) can also be taken at this time. **The proposed conditions require that, once the reservoir is operational, the minimum flow abstraction may only occur in the following circumstances:**

a. When the reservoir level is below 50% and the long-term weather forecast shows that minimum flow conditions are likely to continue; or

b. When the reservoir level is below 30% irrespective of the long-term weather forecast; or

c. When there has been a failure of the pipeline conveyance between the reservoir and the water treatment plant (eg pumping failure, pipeline break) that is unable to be remedied within 12 hours.

In all of the above circumstances, the following criteria will also be required to be met:

- The highest (most restrictive) restriction level in the Water Demand Management Plan shall be enacted and actively monitored and enforced by Council.
- If the abstraction is exercised due to reservoir level triggers, there shall be prior notification to iwi/hapū and Horizons Regional Council. If the abstraction is exercised due to conveyance pipeline failure, these parties shall be notified within 24 hours of the minimum flow abstraction commencing.
- Weekly status updates as to the reservoir levels, effectiveness of restrictions, actions being undertaken to give effect to any repairs (if applicable), and likely timeframe for ceasing the minimum flow abstraction shall be provided to iwi/hapū and Horizons Regional Council for the duration of the minimum flow abstraction period. These updates shall be in an appropriate format (eg email or similar).
- Within two months of the minimum flow abstraction ceasing and the system returning to normal operating conditions, a report to sufficient detail and appropriate format to address the matters (eg email , memo or similar), shall be provided to iwi/hapū and Horizons Regional Council detailing the reasons for the minimum flow abstraction occurring, actions taken during the minimum flow abstraction period to minimise effects on the awa, and any recommendations to minimise the potential for the need for this abstraction in the future (if possible).

The above constraints are proposed in order to achieve an appropriate balance between the need to maintain supply to the community for public health and wellbeing purposes, with the need to give effect to Te Mana o te Wai, and to protect and provide for the awa and its life supporting capacity. It ensures that the ability to abstract is available in exceptional circumstances but avoids this being exercised on a regular basis. The notification, reporting and post-event review requirements, which will also require involvement of iwi/hapū, are proposed to ensure that there is transparency, accountability and a continual improvement approach.

4.1.3 Flow Metering & Reporting

The Applicant has telemetered flow metering on its existing Water Treatment Plant (WTP) intake which provides real time data to Horizons Regional Council and also provides data into the HDC's SCADA system and compliance and data recording system (currently Infrastructure Data). This enables real time alerts and operator actions to be taken in the event of potential exceedances of consent limits or other operational matters. The Infrastructure Data system also enables dashboarding of the water supply and wastewater systems that the Council operates. A Levin WTP dashboard has been created for oversight and reporting on the operation and compliance of the system from both a resource consent compliance and drinking water standard compliance perspective. The SCADA system also enables remote operational control so that operator attendance at site is not necessarily required to address operational matters.

The new reservoir intake will include flow meters which are verified in accordance with manufacturer requirements, and which have telemetry output to enable real time data provision to both District Council (as consent holder) and Regional Council (as consent authority). The flow meters and telemetry systems at both intakes will continue to operate throughout the term of consent including regular flow meter verification as required under standard consent conditions imposed by Regional Council which are on the existing water take permit consent and would be expected to be imposed on any grant of consent to this application. This ensures compliance with the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010.

In addition to reporting of the amount taken at each intake, the SCADA and reporting system will be upgraded as part of the construction and commissioning of the reservoir, to include the following elements:

- **River flow monitoring at the reservoir intake site.** The design of the river flow monitoring system will be developed as part of the detailed design of the intake and will be submitted to Regional Council for technical certification prior to construction. The river flow data will connect to the pump control system for the river intake via the SCADA system. Set points will be established in the SCADA system which specify the median flow above which supplementary allocation can be abstracted, and the pump control system will vary the abstraction rate when the river flow is above median flow to ensure that no more than 10% of the river flow is abstracted. The SCADA system allows for set points and controls to be established at different authority levels, and these set points will be set to ensure that they cannot be overridden at operator level without prior approval and authorisation. The river flow monitoring will also be telemetered direct to Regional Council to add to their data records for river flows.
- **Integration of Intake Set Points**: SCADA rules will be established that provide for integration between the reservoir and WTP intake sites to ensure that the allocation limits set for each intake point, as well as the total daily allocation limits are not exceeded.
- **Reporting of Individual and Combined Daily Abstraction:** Dashboards and reporting will be established to enable daily reporting of the amount taken at each intake site as well as the total amount taken across all intakes to enable compliance reporting.
- **Provision of Telemetered Abstraction Data to Regional Council:** HDC officers will work with Regional Council officers to agree and develop protocols for provision of telemetered abstraction data into Regional Council's system. This is likely to include provision of abstraction at each intake site as well as combined abstraction data across all intake sites authorised under this consent.

Temporary Ō2NL Project Construction Water Take

The abstraction of water at the intake site for Ō2NL Project construction water will be carefully managed throughout the construction period with a high degree of communication between HDC and NZTA and its contractors. **HDC recognise and acknowledge that, as consent holder, they will remain responsible for compliance with the consent at the Ō2NL Project intake site.**

The intake at the Ō2NL Project site will include a flow meter and telemetry to enable real time abstraction data to be fed into both the HDC system (as described above) and Regional Council system.

HDC and NZTA have been engaging with iwi/hapū in developing the proposal for the use of water for the Ō2NL Project construction and agreeing protocols for how this will be managed. HDC and NZTA have entered into a Private Development Agreement (PDA) with respect to the overall Ō2NL Project construction and it is proposed that a water supply agreement be developed and included as a schedule to that agreement. A draft water supply agreement is currently being developed and it has been agreed between HDC, NZTA and iwi/hapū that it will be based on the principle of Te Mana o te Wai, namely

- Firstly, water is kept in the awa. There will be no abstraction at the Ō2NL Project intake site when the river is below minimum flow. The proposal to utilise some of HDC's allocation for the Ō2NL Project's construction water also means that additional water is not required out of the Ohau River that would result in over allocation of the river. Further, it reduces the amount of water that needs to be abstracted from other water courses along the Ō2NL Project corridor.
- Secondly, water is available for public water supply. NZTA recognises that it is only able to utilise any spare allocation within the HDC consent after the community water demand has been met.
- Thirdly, remaining allocation may be used by NZTA for construction water. This means that the water available to NZTA on any given season and day will vary. To manage this, a high degree of communication will be required between NZTA, its contractors and HDC. During winter, when the base demand for the community is low (ie, at present base demand is in the order of 8,000 - 9,000 m^3/day) there is the ability for NZTA to abstract the required amount on an ongoing basis without risking non-compliance with the overall water take. In these periods, demand for

construction water is also likely to be at its lowest. During summer (and shoulder months), community demand is higher and closer day-to-day management of the amount of water able to be taken for the Ō2NL Project construction will be required. The proposed communication protocols recognise this variability and include for more frequent (ie daily) communications between HDC and NZTA in summer / high demand periods. It is proposed to manage the system on a "by exception" basis whereby during winter periods, NZTA will be able to abstract up to their requested maximum unless HDC operators advise otherwise on any given day; during summer periods, the exception will be reversed in that NZTA will generally not be allowed to take (or will only be allowed to take to a much lower limit) unless HDC operators advise otherwise on any given day. Community demand is generally predictable on a daily-weekly basis by the operators based on recent trends and weather forecasts, and conservative estimates will be made by the operators to advise NZTA as to how much water is available for abstraction. NZTA and its contractors propose to utilise the Ō2NL Project's stormwater ponds for storage of construction water and therefore not being able to abstract on any day, or for periods at a time, is unlikely to impact the construction programme.

4.1.4 Operating Approach & Parameters

The above has described the water take activity in terms of the consented allocation and consent limits sought. That sets out the upper limits as to the proposed activity for which consent is to be sought and is the basis on which the assessment of environmental effects has been undertaken.

This notwithstanding, the actual operation of the system will generally not be occurring at the maximum consented limit. This section describes what the actual operating conditions may be under various scenarios that would be expected during the term of consent sought.

It describes the general operating principles under normal conditions (being whenever the river is above minimum flow), as well as general operating principles under drought (minimum flow) conditions, high turbidity and emergency conditions.

Normal Operating Conditions

The normal operating conditions are when the river is above minimum flow (ie. when the river is above 820 L/s at Rongomatane) and is summarised in Figure 4.3.

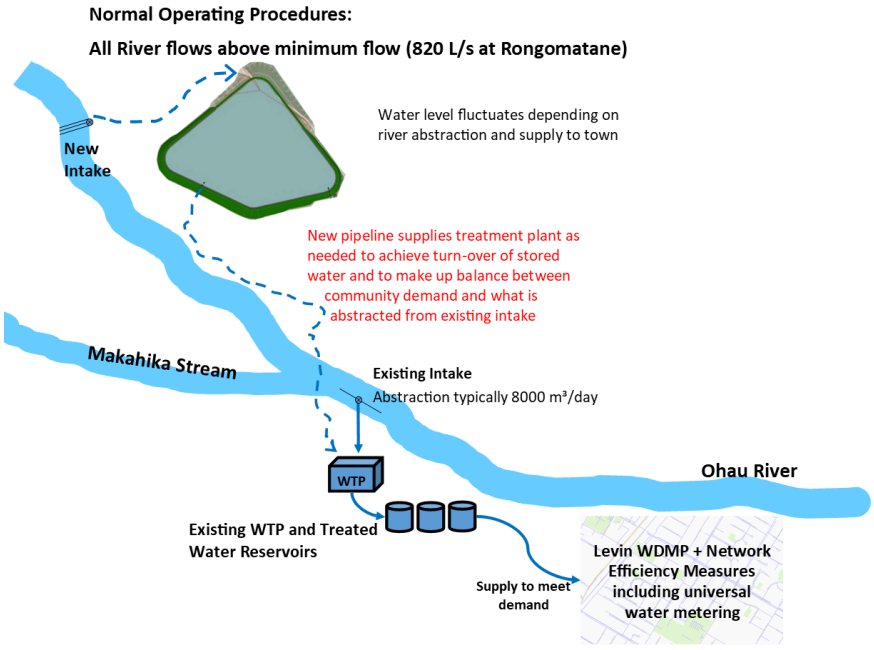


Figure 4.3: Overview of Normal Operating Conditions when the River is above Minimum Flow

The system will generally operate as follows:

Firstly, at all times, community demand will be managed through implementation of the Water Demand Management Plan including measures undertaken by Council to reduce leakage from the system (as described in Section 4.1.4), water metering and charging consumers for high water usage, and measures to encourage sustainable water use such as use of rainwater tanks on new properties. For example, the Taraika Plan Change which provides for the Taraika Growth area and some additional 3,500+ houses and mixed commercial area, requires rainwater tanks on all new dwellings to meet the District Plan permitted activity standards.

Water will be abstracted from the Ohau River at the existing intake site. This is from the core allocation under the One Plan which is already allocated to Horowhenua District Council. The abstraction may vary depending on specific operating conditions, but typically the abstraction at the existing intake site will match base demand less any water required to be supplied from the reservoir to achieve turn-over in the reservoir for purposes of maintaining stored water quality.

While more can and is routinely abstracted during summer periods at the moment, generally operating the existing intake at base demand levels will reduce the risk of failure of the existing intake and also reduce the frequency at which the existing intake needs to be scarified thereby reducing bed disturbance (via the exercise of consent ATH-2008010962.02).

The amount of water abstracted from new reservoir intake site will also vary depending on specific operating conditions, but will generally be as follows:

- When the river is above minimum flow (820 L/s) and below median flow (3,810 L/s at Rongomatane): Abstraction will be up to 7,500 m^3/day (ie being the 15,409 m^3/day total less the 8,000 m^3/day likely to be abstracted from the existing intake site and rounding that figure). This water is abstracted as part of the core allocation provided under the One Plan and already allocated to Horowhenua District Council and is to be used to fill the reservoir.
- When the river is above median flow (3,810 L/s at Rongomatane): Abstraction will be the amount of core allocation able to be abstracted as per above, plus 10% of the river flow, as measured at the abstraction point. The 10% of the river flow is the supplementary allocation provided for under the One Plan.

The reservoir would generally be operated to be as full as possible coming in to high demand periods, subject to community demand and abstraction restrictions. Some water will be routinely used from the reservoir to supply treatment plant as necessary to ensure adequate turn-over and maintain quality of stored water. As community growth occurs, more seasonal fluctuations in the reservoir level are expected. In general, the reservoir levels would be at their fullest leading into the summer period. During the summer period, abstraction to full the reservoir is likely to be more restricted as the river will be less frequently above median flows (in which case abstraction will be limited to the core allocation only and the additional supplementary allocation may not be available) and community demand will be at its highest. The reservoir levels will progressively decline over the summer period. During winter, the reservoir levels will then progressively increase as the community demand decreases and the ability to abstract supplementary allocation to fill the reservoir will increase. Ideally the reservoir will be maintained above 50% levels at all times in order to ensure there is sufficient stored capacity to maintain emergency supply to the community should that be needed.

Water from the reservoir will be supplied directly from the reservoir to the treatment plant via the new pipeline to provide adequate reservoir turn-over, and to make up the difference between the community demand and the amount of water which is abstracted at the existing intake. For example[18], if the community demand is 18,000 m^3/day then this would generally be supplied via abstracting 8,000 m^3/day from the existing intake site and 10,000 m^3/day from the reservoir.

[18] *This is an example only. For context, it represents the projected summer peak around the year 2036.*

Minimum Flow / Drought Period Operating Conditions (Ohau River is below 820 L/s)

A key benefit of investing in the reservoir is to be able to reduce the need to abstract from the River when it is below minimum flow. At present, Council is authorised to abstract up to 13,000 m^3/day from the Ohau River when the River is below minimum flow in order to maintain supply to the community, plus a further 750 m^3/day of non-consumptive take. The reservoir enables Council to not exercise the minimum flow abstraction (other than the non-consumptive take) except in extreme drought or exceptional circumstances (e.g. failure of the reservoir-treatment plant pipeline).

Normal operating conditions when the river is below minimum flow (820 L/s) will be as follows:

- No consumptive abstraction from either of the river intakes (ie no abstraction from the existing intake and no abstraction from the new reservoir intake).
- Up to 750 m^3/day of non-consumptive take at the existing intake.
- Highest level of water restrictions imposed on community water use in accordance with the WDMP.
- The community will be supplied with water directly from the reservoir to the treatment plant. No river abstraction, other than the non-consumptive take.

In extended drought periods, the Council may need to exercise the ability to abstract direct from the River at the existing intake site when the river is below minimum flow. This is likely to be in extended droughts only and will only be exercised if maintaining supply from the reservoir is not possible without significantly compromising the ability to meet water supply obligations or emergency reserves.

It is proposed that the existing ability to abstract from the river below minimum flow only be exercised if the criteria detailed in Section 4.1.2 are met.

One of the considerations is the likely remaining length of extended drought and the way in which the reservoir levels are balanced. For example, whether it is best to avoid any and all minimum flow abstractions from the river and draw down the reservoir to the lowest possible level. In this instance, if the drought extends beyond the reservoir's storage capacity there would be a need to abstract all of the necessary water from the river. Alternatively, it may be that in extended drought situations, abstraction from the river should occur when there is still a reasonable amount of water in the reservoir. In that case, the community's demand (restricted in accordance with the highest level of the Water Demand Management Plan) could be met by a mixture of supply from the reservoir and river abstraction at a lower rate. That is, is it better to have a shorter duration, higher take below minimum flow; or a longer period of abstraction below minimum flow but with lower abstraction rates?

This will always be a careful balancing act between the objective of not abstracting from the river under minimum flow conditions and the need to manage demand and storage levels to ensure continuity of supply and prevent public health risks associated with supply being interrupted. It is therefore important that the consent conditions provide the flexibility to enable management and operational decisions to be made that provide for community health whilst also providing for the life supporting capacity of the river; while at the same time being sufficiently restrictive that they do not encourage use of the minimum flow abstraction as an operationally easier route than managing the reservoir appropriately.

Figure 4.4 provides some indicative examples as to how this “balancing” act may play out, depending on when this event occurs during the term of consent and the level of demand. It assesses the projected water demand at two points. Firstly, the projected peak demand is assessed. In this scenario, it is assumed that the existing water conservation and demand measures continue and therefore the projected peak is simply the existing peak demand projected on the basis of population growth. The second scenario assesses the existing average demand projected forward on the basis of

population growth. This scenario, in essence, assumes that there is a significant change in the way in which people use water such that their overall water use is reduced considerably. In reality, what actually happens is likely to fall somewhere between these two scenarios.

In the example in Figure 4.4, it is assumed that, when the reservoir falls below 50% of its effective volume, the community demand is met by a combination of 8,000 m^3/day from the river and the balance from the reservoir. In this example, and with the current demand management / water restrictions in place (Scenario 1 in the figure), there is sufficient volume in the reservoir to maintain supply to the community in the 100-year return period event for consecutive days below minimum flow (26 days) and no abstraction from the river would be needed if this event were to occur in the near future. As the community grows and at the end of the consent term sought, the reservoir volume would need to be augmented by supply from the river to get the community through the 1:100 year drought period.

If community demand could be reduced to the point that future peak per capita demand is closer to the existing average per capita demand, then the reservoir provides sufficient volume to meet the 1:100 year minimum flow period without abstraction from the river through to approximately 2040. After that time, supply from the reservoir would need to be supplemented with a river abstraction.

Note that these are examples only. The actual growth that has occurred, community demand, abstraction rate from the river, drought period, reservoir level trigger points and minimum flow abstraction will vary. The operating principles will be further developed throughout the detailed design process and via engagement with iwi/hapū, and it is proposed that these be documented via a Water Supply and Reservoir Operational Plan to be prepared as a condition of consent. In terms of this application, the assessment of effects has been undertaken assuming a worst case scenario effect of the consent being exercised at its maximum extent as described in Section 4.1.1.

Effective Storage Volume - Resevoir Full	740,000	m3
Draw Down Reservoir to XX% before supplementing from River	50%	
When supplementing from river, abstract XX m3/day from River	8,000	m3/day
Minimum reservoir volume required	30	days @
	20	l/person/day

Scenario 1: Existing water demand management:
All projections based on 95th percentile growth

Time Period	Population	Demand (m3/day)	No. of days Supply is from Reservoir before needing to be supplemented with river abstraction	No. of additional days supply as combination of Reservoir and River	Total days of drought through which supply is able to be maintained
2025	22163	14,300	26	57	82
2030	25296	15,000	25	51	75
2040	29041	19,800	19	30	49
2045	33471	23,000	16	23	39
2055	51793	30,500	12	15	27
2060	59057	34,900	11	12	23

Scenario 2: Significantly Improved water demand management:
All projections based on 95th percentile growth

Time Period	Population	Demand (m3/day)	No. of days Supply is from Reservoir before needing to be supplemented with river abstraction	No. of additional days supply as combination of Reservoir and River	Total days of drought through which supply is able to be maintained
2025	22163	9,800	38	198	236
2030	25296	12,200	30	84	115
2040	29041	15,000	25	50	75
2045	33471	17,600	21	36	57
2055	51793	23,500	16	22	38
2060	59057	26,800	14	18	32

Shaded cells represent scenarios where supply is able to be maintained during the 100 year return period event for consecutive days below minimum flow (26 days)

Figure 4.4: EXAMPLE Supply Scenarios in Extended Drought Conditions[19]
Supply Arrangements are based on reservoir fill effective storage volume of 740,000 m^3

[19] *The population figures are for the supplied population and differ from those discussed in Section 3.1.4 which relate to the overall District projected populations. Water demand projections have assumed the District wide population growth rate is applied to the current Levin Water Supply connected population.*

4.1.5 Water Demand Management Plan

The existing consent requires that the system be managed in accordance with a Water Demand Management Plan (WDMP) which is required to be updated every three years.

The proposal represents an opportunity for HDC to shift its WDMP to match the new regulatory framework for water services and to ensure that it is implemented in a way which gives effect to Te Mana o te Wai.

The context in which HDC delivers its drinking water services has changed dramatically since the existing consent was granted. At that time, the primary driver for demand management was Policies 5-12 and 5-18 of the One Plan (now policies LF-FW-P15 and LF-FW-P21). Policy LF-FW-P15 requires that municipal water supplies be managed within the reasonable use calculation defined in that policy, largely based on 300 L/person/day for domestic use, a reasonable use assessment for non-domestic uses, and ensuring network leakage is less than 15% of water demand. Policy LF-FW-P21 requires that, when the river is at minimum flow, water demand is reduced, with the domestic use reducing to 250 L/person/day. Council's existing WDMP was developed to give effect to these policies. As a result, and as directed by Condition 12 of the existing consent, it is a WDMP which is predominantly reactive in that it seeks to impose restrictions in response to river flows and to address leakage within the network.

HDC is now required to deliver its drinking water services in a significantly different, but more integrated, statutory framework that recognises the intrinsic value of wai and the awa. The primary statutory driver has been the introduction of the Water Services Act 2021 and establishment of a new water services regulator – Taumata Arowai. The outcome is that the statutory expectations and requirements of HDC as a water services provider have changed fundamentally and there is increased regulatory oversight to ensure that obligations are met. This will be further strengthened through the planned introduction of an economic regulator for the water services industry.

The statutory framework now includes:

- The National Policy Statement for Freshwater Management 2020 (as amended in 2024) ('NPSFM') which has the objective of managing freshwater in a way which prioritises **first, the health and well-being of water bodies and freshwater ecosystems and second, the health needs of people**. It introduces the concept of Te Mana o te Wai as a fundamental concept that is relevant to all freshwater management (and not just specific to the NPSFM) and defines six principles encompassed in Te Mana o te Wai.
- **Water Services Act**, Section 14 which requires HDC to, when exercising or performing any function as a water service provider, give effect to Te Mana o te Wai (to the extent that it applies to that function). This means that, **in all activities that HDC undertakes as a water service provider, it needs to give first priority to the health and wellbeing of the awa.**
- Water Services Act, Section 25 which requires the water supplier to ensure that a sufficient quantity of drinking water is provided to each point of supply. It is important to note that the requirement is for the quantity of water to be "sufficient" and it does not mean that it is unfettered. The Act defines sufficient as:
  - "the quantity of drinking water that is sufficient to support the ordinary drinking water needs of consumers at the point of supply; or
  - If compliance rules have been made that prescribe the quantity of drinking water or a formula for determining the quantity of drinking water that is sufficient to support the ordinary needs of consumers at a point of supply, the amount specified in, or calculated according to the formulae set out in, those rules".

  To date no compliance rules have been set and there has been no numerical determination as to what is considered a "sufficient quantity". Section 25 also states that the obligation to provide sufficient quantity of water does not prevent a drinking water supplier from restricting supply, if

necessary, because of (amongst other items) "environmental factors affecting a source of a drinking water supply" or "cultural factors affecting a source of a drinking water supply."

- **Network Environment Performance Measures** under the Water Services Act which requires HDC to report, on an annual basis, to the regulator Taumata Arowai on a range of performance measures regarding water demand and efficiency. This information is made publicly available and therefore brings increased regulatory oversight, performance assessment and transparency to the way in which Council is using the water which it is allocated for abstraction from the awa. The Network Environment Performance Measures required to be reported include:
  - Amount of water supplied in total as well as the amount supplied to non-residential water use.
  - Response times to breaks and faults. This is because breaks and faults can be a large contributor to the amount of water lost from the network if not responded to in a timely manner.
  - Percentage of pipes in poor or very poor condition; and average age of pipelines. This is because the age and condition of pipework is an indicator as to the potential for leakage to occur. A "poor" condition means that renewal should be considered, and a "very poor" condition means that the asset is approaching being unserviceable[20].
  - Average system pressure and whether or not a reference level for pressure has been set. This is because pressure within the pipe network is a key factor in the amount of leakage which may occur. In this measure, there is a balance required to be achieved by network operators in maintaining high enough pressures within the network to avoid backflow of contaminants into the network and to meet customer levels of service for pressure (eg for shower usage, but also to meet firefighting requirements), whilst reducing pressure to avoid excessive and unnecessary leakage.
  - Number of days of water restrictions applied.
  - Estimated total losses (m^3/year) of water from the network.
  - Current annual real loss and Infrastructure Leakage Index. These are two principal measures used to assess the performance of a water supply network in terms of leakage management. They are discussed further below.
  - Median residential water consumption (l/day/connection).
  - Whether or not there is a water conservation education programme in place.
  - The number of residential and non-residential connections with water meters.

The above measures, which are required to be reported to Taumata Arowai annually and then assessed and published by Taumata Arowai, provide a high level of regulatory oversight as to how the network is operated and whether or not appropriate benchmarks are met. The Network Environmental Performance Measures also mean that there is commonality of reporting systems and measures for all networks across the region as well as nationally allowing comparison across communities.

Given the extent of reporting and benchmarking required under the Water Services Act, is it proposed that consenting conditions relating to efficiency, demand management and network losses rely on this reporting. A condition is proposed that will require HDC to provide the consent authority with a copy of Network Environmental Performance Measures reported to Taumata Arowai as well as a copy of any feedback received from Taumata Arowai on the Council's performance.

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[20] *Classification is to be in accordance with the IPWEA International Infrastructure Management Manual. There is also a network environmental performance measures as to the percentage of pipes with a condition grading. This will ensure that any councils reporting low percentages of poor / very poor condition pipework is an accurate representation and not skewing the outcome by not undertaking condition assessments.*

The outcome of all of the above, is that HDC is now required to manage its water supply in a way which gives first priority to wai and the awa. This means that water must be managed in a way which recognises the value and importance of the water and ensures efficient and reasonable use of the water at all times, and is not limited to water restrictions at times when the river is low.

The introduction of the off-storage reservoir has the ability to decouple the community water demand from the river flow, and there is the risk that this will then be seen by some members of the community as a way in which restrictions can be avoided and water can be used as-and-when desired. Such a mindset is inconsistent with Te Mana o te Wai. The WDMP therefore needs to emphasise the need to conserve and use water appropriately at all times, as well as measures required to minimise leakage and increased measures to be used during drought conditions.

It is proposed that the WDMP be updated within six months of commissioning of the reservoir to include, as a minimum, consideration and assessment of the following measures:

- Measures to ensure, on an ongoing basis, that the water supply network is managed in accordance with best practice measures with respect to leakage and demand management including target performance standards and monitoring and reporting to be undertaken to track progress towards those performance standards.
- Measures to encourage valuing of water and reduce use / achieve efficient use year-round ensuring transparency and may include information as to how the supply system works and where Levin's water comes from; interpretative displays and information along the river corridor and at or adjacent to the reservoir site. It should include measures to increase understanding of the overall water cycle, ie that water use also contributes to the wastewater system and any capture and use of rainwater reduces impacts of stormwater discharges.
- Measures to encourage or require use of rainwater for non-potable use at a property level (eg rainwater tanks which are required under the Council's Taraika Plan Change) and adoption of water sensitive design.
- A refreshed and updated water conservation / restriction framework to be implemented during dry periods including development of trigger levels based on a combination of community demand, reservoir levels and river flows.
- A review of the effectiveness of the introduction of universal water metering throughout the district and how the information obtained can be used to improve consumer engagement and understanding of individual water consumption. [Council commenced a roll-out of universal metering in March 2024 and expects to have completed installation of meters on all connections in 2025].
- Metering of industrial users and water use audits for high quantity water consumers.
- Alignment of measures in the WDMP with Council policies and bylaws including any amendments required to these instruments to ensure the effectiveness of the WDMP and timeframe for those amendments (eg review and update of Water Supply Bylaw if necessary).

Network Leakage and the Infrastructure Leakage Index

The primary industry measure for assessing the efficiency of the network, and the effectiveness by which the water supplier is managing the network to minimise losses, is determined by the Infrastructure Leakage Index (ILI). The ILI has been developed through international experience (International Water Association, IWA) and is identified in the New Zealand Water Loss guidelines as "the best performance indicator for metric benchmarking (comparison between systems) of real losses management performance"[21]. The ILI at any point in time is determined by:

[21] *https://www.waternz.org.nz/Folder?Action=View%20File&Folder_id=101&File=100503_waterloss_guidelines.pdf.*

1. Firstly, calculating the "Unavoidable Annual Real Losses" (UARL) which is the best possible performance that can be achieved - with maximum effort and costs - taking into the specific characteristics of the system (ie number of connections, length of pipework, average network pressure). This is a theoretical calculation based on the network characteristics.
2. Secondly, using a water balance model to calculate the "Current Annual Real Losses" (CARL), ie how much water is actually being lost. The water balance is done by taking the total amount of water supplied (as measured at the exit of the treatment plant) and subtracting known uses (ie, all metered uses), and best estimations of unknown uses such as unmetered connections, network leakage and losses through faults and bursts. The NZ Water Loss Guidelines provide the methodologies for estimating these values.
3. Thirdly, calculating the ILI by calculation the ratio of CARL:UARL. An ILI of 1.0 would mean that the actual losses are the same as the best that could be achieved for that particular system. An ILI of 2.0 would mean that the actual losses are twice what could theoretically be achieved.

As noted in NZ Water Loss Guidelines, the CARL "is continually tending to increase as the system gets older, and new leaks and bursts occur" and, by definition, this means that the ILI will be continually trending upwards as a network ages unless management intervention is undertaken. The NZ Water Loss Guidelines state (from the IWA guidelines) the four complementary leakage management activities which are required to be adopted to constrain this increase in losses and ILI as the network ages. These four complementary leakage management activities are shown in Figure 4.5.

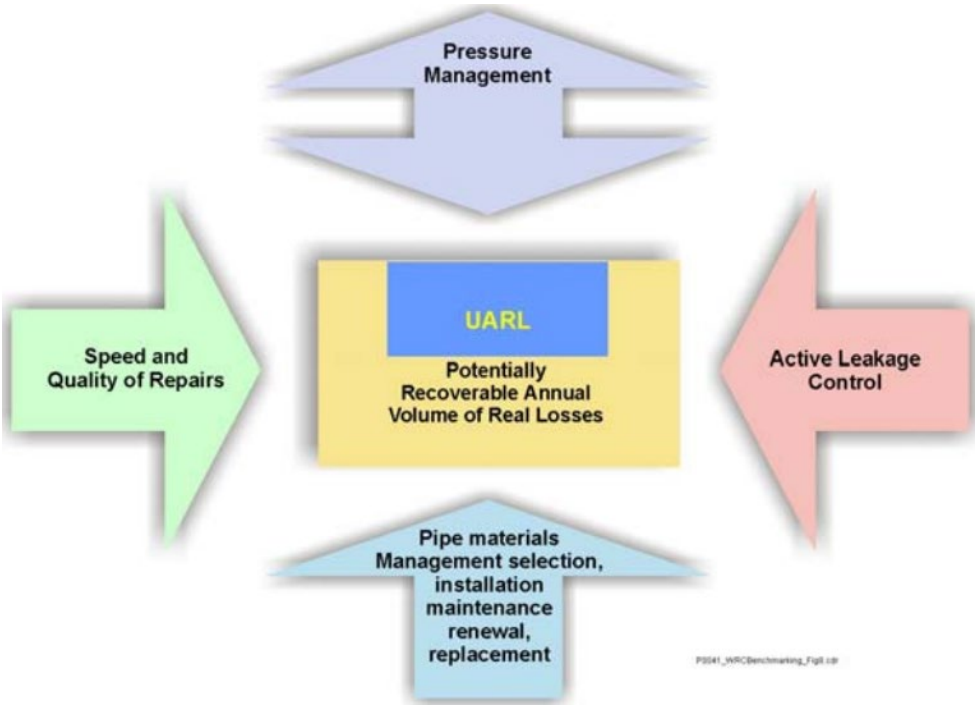


Figure 4.5: The Four Complementary Leakage Management Activities Required to Address Leakage
Source: NZ Water Loss Guidelines

HDC's Current and Proposed Activities to Manage Leakage

The Council's Water Supply Leakage Report (March 2022) previously provided to Regional Council as a compliance requirement of the existing water permit details what Council is currently doing to manage leakage. This includes:

- Network reconfiguration and significant investment in meters and monitoring and control equipment to establish fifteen District Metered Areas (DMAs) and four Pressure Management Zones (PMZs) complete with pressure reducing valves to optimise supply zone pressure.
- Ongoing and active monitoring of the system using the i2O Advanced Pressure Management Solution. This includes a network of 3G connected loggers to enable real time monitoring. The system optimises the pressures within the supply network to achieve both a reduction in leakage and "open-tap" consumption. The long-term benefits of pressure optimisation are the extension of the remaining asset life, a reduction in operating costs due to lower burst rates and sustainable water use. Alarms are set to notify operators of any significant changes that would indicate increased leakage and trigger further investigation and, if necessary, remedial works.
- Use of acoustic leak detection equipment (such as ground microphone and leak noise correlator) to identify invisible leaks that do not surface and are unlikely to be reported. While such leaks normally have a very minor flow, they can go undetected for long periods which can add up to significant losses. In the 2020-2021 water year, this work identified 156 leaks across the Council network and private connections which were able to be rectified resulting in a reduction in losses of 384 m^3/day or approximately 4% reduction in total water usage.
- Asset Management and Planned Water Main renewals. This is a programme of planned water main renewals to renew pipework which is of poor condition or at the end of its useful life. Over the last five years, just under 5% of the total water mains length has been renewed.

The Leakage Report also identifies the following actions (in addition to continuing the above) will be implemented to further improve leakage management:

- An Advanced Meter Reading trial which uses smart meters with built in leak alarming and flow logging capability. This will determine if the extent of private side leakage (i.e. leaks within private property) compared to what has been estimated in the water balance and enable these estimates to be improved.
- Review of the criteria for pipeline renewal selection in order to place more emphasis on leakage in the relevant areas now that permanent DMA flow monitoring is being carried out.
- Consumer awareness campaigns to gather more momentum with fixing leaks on private property.

Since the above actions were identified, Council made the decision to invest approximately $6.1 million in universal metering and leakage detection across the district (ie water meters on each connection). Digital smart meters are being installed to provide high quality data on water consumption and to assist to identify and address leakage throughout the network and on private property. As noted above, Council is currently in the process of installing these meters with the installation programme commencing in March 2024 and expected to be completed in 2025.

Levin Network's Performance: Infrastructure Leakage Index (ILI)

The investment in metering and pressure management discussed above means that the Council is able to track ILI on a monthly basis. The trend for the recent years has been shown above in Figure 3.6.

Council has adopted, in its Long-Term Plan, a performance target of ILI in Band B (being an ILI of between 2 and 4). This target has not been achieved and the measures discussed above have been identified to reduce leakage further and to achieve the Band B target. Figure 3.6 does show an increasing trend between October 2021 and May 2022 when resourcing for leakage management was reduced. The marked change towards a decreasing trend from May 2022 occurred through reinstatement of resourcing and commitment to the pressure management system. Figure 3.6 therefore demonstrates the need for ongoing investment in, and commitment to, leakage and pressure management.

Once the universal smart meter roll-out has been completed, HDC will be able to identify, assess and respond to leaks in a far more timely manner which is expected to assist greatly to achieving and maintaining the target ILI.

4.2 Proposed Reservoir Intake

The proposed reservoir intake will be a sub-surface infiltration gallery installed beneath the bed of the river. It will consist of a series of perforated pipes laid horizontally across the river (nominally six) within gabion baskets and then overlain with river gravel. The existing river gravels / stones / boulders will be stockpiled at the commencement of construction and used to cover the infiltration gallery upon completion.

The size of the intake is approximately 45 m lengthwise along the river and 27 m across the river bed. These dimensions are subject to detailed design and may vary by up to 50% in total area. Within the gabion basket array is a series of backwash diffuser air pipes to provide for routine clearing of the fine material from the intake structure and to prevent blockages.

Intake works will also be constructed on the true left bank. This includes removal of vegetation and terracing of the riverbank to provide a stable platform for access and installation of the pump and sedimentation chamber. This is shown in the cross section below (Figure 4.7). The terracing is required to ensure that the top of the pump and sedimentation chambers are above the 100-year flood level and that they are structurally stable. That is, terracing to lower than the proposed height would make the structure susceptible to overtopping in flooding, while keeping the existing bank profile would result in very tall chambers which are less stable.

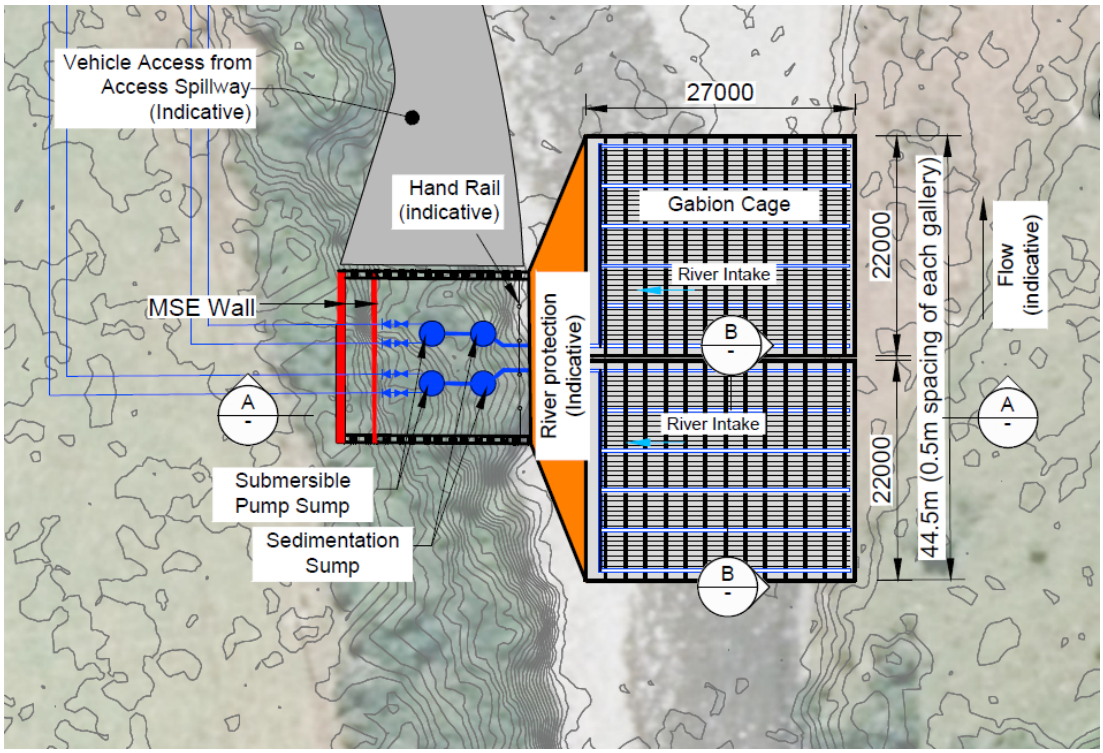


Figure 4.6: Plan Showing Size of Intake Structure

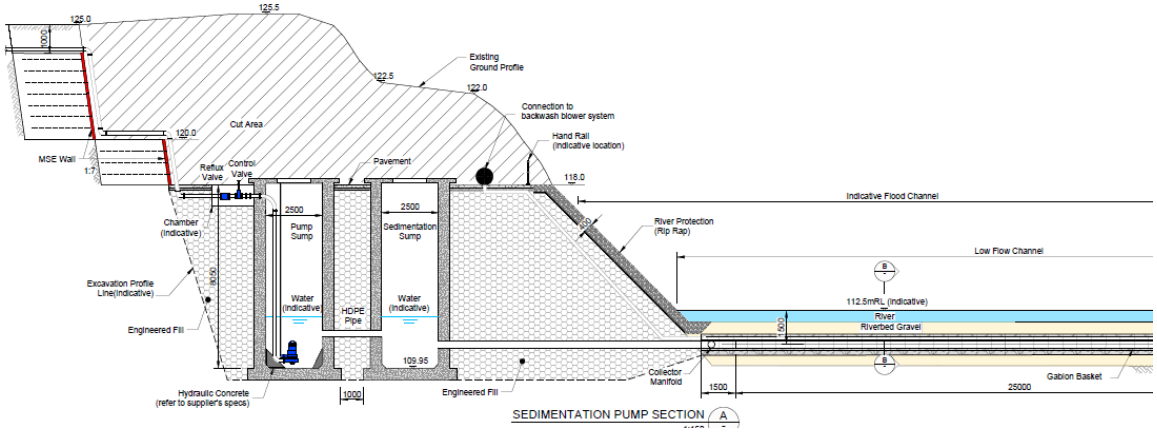


Figure 4.7: Cross Section of Proposed Intake Structure

A vehicle access track will also be constructed to enable maintenance and operations access. This includes access to remove sediment within the sedimentation sump which will be extracted via a sucker tank or similar and taken to an approved off-site disposal location.

The excavation height to create the terrace is in the order of 8 metres.

The infiltration gallery is described in detail in section 8 of the Feasibility Design report (Appendix B). As described in that report, encasing the intake pipework within the gabion baskets arrangements has the following advantages:

- It is more likely to resist the effects of high energy river flows.
- The collection pipes and backflushing pipes have a greater degree of protection from being swept out in high river flows.
- The gabion baskets can be filled with relatively open gravel and cobbles to maximise the potential yield from the infiltration cells.
- It reduces the construction effects in terms of length of construction and disturbance as the infiltration gallery does not need to be as deep as alternative arrangements.

Backwash System

Over time, and depending on the sediments within the source water, infiltration galleries can become blinded with sediment and the abstraction rates decline. Often this is managed by backwashing with water which has been abstracted, however, this is relatively ineffective and may also require works in the river bed to maintain infiltration gallery performance.

For this intake, an air backwash system is proposed to reduce maintenance requirements and minimise bed disturbance. Air and water will be used simultaneously and is considered the most effective and efficient method as its necessary water flow is less than that required for full bed fluidisation (as is required with water backwash alone).

The intent is to use the backwash system relatively frequently as standard operations. This ensures that there is not a lot of sediment build up between backwashes and thereby prevents sedimentation effects occurring if more sediment were able to build up before backwashing. The required frequency will be determined through operational practice during the first few years of the reservoir intake and will be documented through the proposed Water Supply & Reservoir Operational Plan.

Construction Methodology

The greatest effects of the proposed activity are likely to occur during the construction of the infiltration gallery and intake works. This is because it requires the riverbed to be excavated in order to lay the infiltration gallery below bed level.

The construction will be undertaken in accordance with all best practice standards and guidelines for working in waterways, including the "National Works in Waterways Guideline - Bet Practice Guide for Civil Infrastructure Works and Maintenance" published by the Ministry for the Environment. This includes, but is not limited to, diversion of the flowing channel around the construction site including fish capture and relocation, in order for the works to be undertaken "in the dry".

Appendix I details the construction methodology proposed and measures to be taken to minimise the effects of the construction. In summary, the construction will be undertaken as follows (refer Appendix I for more details):

1. Construction of a channel to divert the river flow away from and around the construction footprint. Fish capture and relocation will also be undertaken to ensure fish are not stranded in the section of the river bed which will become dry. The methodology notes that works will need to be aligned with non-critical times for fish spawning and migration. This will be determined in consultation with Department of Conservation, iwi/hapū and Fish and Game during the detailed design stage. Table 15 of the One Plan identifies certain times of the year when river bed works are excluded for specific values (eg whitebait migration, inanga spawning, etc). None of these values or exclusion periods apply to the site.
2. Depending on anticipated river flows and natural groundwater levels, construction of further barriers such as Aquabarrier, bunds and temporary pumping may be required. These will be installed, as necessary. If pumping is used, appropriately sized fish screens will be included to prevent entrainment. Sediment control measures such as silt fences or other will be installed.
3. The infiltration galley will be excavated to the design level below the river bed. Riverbed material to be re-used (e.g. to cover the infiltration gallery) will be stockpiled. The gabion mattress array will be placed and then overlain by the natural river bed materials.
4. Remaining earthworks will be completed; pipework will be laid to the sedimentation sump and pump sump; sedimentation sump and pump chambers will be constructed and intake structure completed.
5. Upon completion, all equipment and the river diversion will be removed and flow reinstated to the normal river flow path. This includes fish capture and relocation from the temporary flow diversion path before reinstating the river flow to the permanent channel.

4.3 Reservoir, Spillway and Ancillary Infrastructure

The proposal is to construct a large scale off-river reservoir of 855,000m^3 total volume and an effective storage volume in the order of 740,000 m^3. Associated infrastructure will also be constructed and operated on the site, including access ramp for operational access to the reservoir, spillway and discharge structures, power supply, fencing and landscape planting, access road and parking for light vehicles, and buildings for housing of pumps, diesel back-up generator and aeration equipment.

Note: the access ramp into the reservoir is for operational and monitoring access by authorised persons only. There is no proposal for public access or recreational use of the storage reservoir.

The feasibility report included in Appendix B describes the proposed activities on the site in detail.

Of relevance to this application is the large-scale earthworks that are required to construct the reservoir, spillway and associated infrastructure.

Bulk fill for the reservoir embankments will generally be sourced from excavations onsite. Geotechnical investigations to date have found that the site material is expected to be suitable for the embankment construction and to meet the compaction and design standards for dam safety. This is discussed in the feasibility report in Appendix B.

The earthworks construction activities have been described in the Erosion and Sediment Control Plan (Appendix J) for this activity as follows:

> *The reservoir embankment includes broad upstream and downstream shoulders of bulk fill, a central filter and chimney drain. The crest width is six metres, providing suitable access to the crest. The upstream slope is overlain by a geomembrane liner system. The surface of the geomembrane liner is protected by riprap across the base of the reservoir and near the embankment crest.*
>
> *The process involves topsoil materials to be stripped from beneath the footprint during construction. The design assumes that the embankment bulk fill will be sourced from excavation within the reservoir site itself consisting of alluvium terrace and older alluvium. Excavation depths increase towards the reservoir's southern end, which follows two sloped terraces. The potential excavation depths vary between 3 m to 12 m within the reservoir's footprint.*
>
> *Some processing of granular materials may be required and would likely require an area in the land immediately to the north of site. This would include some potential stockpile storage.*
>
> *Most of the construction is likely to occur in summer periods which will minimise sediment generation however dust management will remain a key consideration. The earthwork activity involves the removal of approximately 800,000m^3 of surplus material which will be removed from the site to another approved infrastructure project and/or to an approved cleanfill site. This volume is the maximum / conservative volume that would be taken off site through the Project duration with some of the material to be used within the Project embankments and footprint.*
>
> *On completion of earthworks the liner system is to be installed across the full extent of the reservoir. This consists of an HDPE low permeability geomembrane with adequate protection by geosynthetic geotextiles. In addition, across the base (under the liner) there is a groundwater collection layer of granular drainage materials and HDPE collection pipes embedded within it.*

A draft Erosion and Sediment Control Plan (ESCP) has been developed as part of this application to ensure that the earthworks can be undertaken in a way which avoids or minimises sediment discharges to water bodies. Refer to the draft ESCP in Appendix J for details.

4.4 Proposed Discharges and Diversion

Discharge permits are sought for two types of discharges, one which includes a diversion:

1. Discharge of diverted groundwater to the Ohau River during construction (dewatering) and operation of the reservoir.
2. Discharge of stored water and rainfall to the Ohau River in event of reservoir levels exceeding full height or as necessary for reservoir and water quality maintenance purposes.

The location of these discharges is shown in Figure 4.8.

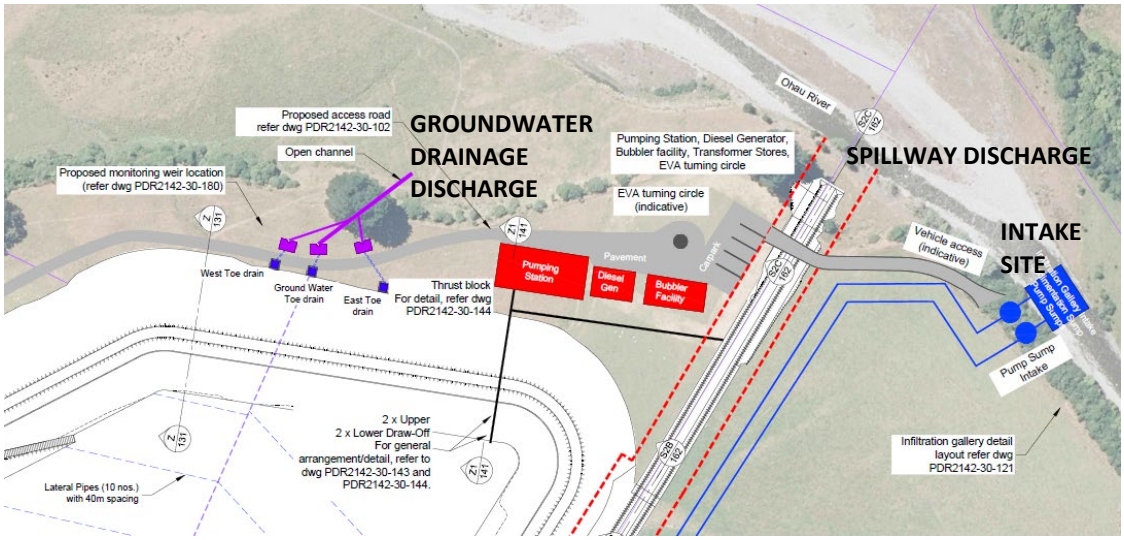


Figure 4.8: Location of Discharges on Reservoir Site (extract of drawing PDR2142/30/104 in Appendix B)

4.4.1 Groundwater Diversion and Discharge

A groundwater diversion system will be installed under the reservoir and will collect any intercepted shallow groundwater, with monitoring weirs installed to be able to measure the amount of groundwater intercepted. The groundwater will be discharged to land on the lower river terrace approximately 180 m downstream of the intake and spillway (refer drawing PDF2142/30/104 in Appendix B).

Actual discharge volumes will vary depending on climatic conditions and groundwater levels. An assessment of the groundwater volumes likely to be intercepted and discharged has been undertaken as part of the feasibility design process taking into account the current understanding of groundwater across the site and a synthesised rainfall record for the site. This has estimated the following discharge volumes:

- Annual average discharge volume: 27 m^3/day
- Typical winter discharge volumes: 42 m^3/day
- Typical summer discharge volumes: 14 m^3/day

The discharge will be to ground but may result in some overland flow to the river.

During detailed design, the use of this water to support and restore natural wetlands and flow paths within the lower river terrace will be considered and restoration use sought where practicable. For example, it may be appropriate to direct some of this diverted water to the water course which runs at the base of the terrace and / or to undertake wetland restoration in this area. Such use would be for the purpose of restoration as well as to offset any potential effects arising from changes to groundwater seeps in this area due to the reservoir construction. This design will be undertaken in consultation with iwi/hapū and with the advice of a specialist ecologist with experience in restoration.

During construction, groundwater dewatering is likely to be required. The diversion system under the reservoir will be one of the first elements constructed and dewatering water will be discharged at the same location and via the groundwater diversion system as soon as that is installed. Volumes are likely to be similar to those estimated above. Sediment control measures will be put in place to ensure that sediment laden water is not discharged to the river, as per the Erosion and Sediment Control Plan included in Appendix J.

4.4.2 Reservoir Discharge of Stored Water & Rainfall

A discharge permit to discharge stored water from the reservoir to the Ohau River is also sought. The reservoir design includes a spillway from the reservoir in the event of overtopping (eg if the reservoir is fill when heavy rainfall occurs), noting that this should be a very rare occurrence subject to appropriate operating regime of the reservoir levels and given freeboard allowance. Discharge of stored water may also be required if the reservoir is required to be drawn down for maintenance, including for maintaining water quality albeit that the reservoir will be operated to achieve sufficient turn-over via supply of water to the water treatment plant, or other purposes.

The location for water discharge back to the Ohau River is from the toe of the spillway chute immediately downstream of the intake (refer Figure 4.8).

The spillway can discharge water from the surface of the reservoir when the water level exceeds the normal operating levels in the reservoir, and in extreme emergencies or times of maintenance from the lower profile of the reservoir through the low-level outlet which discharges to the lower portion of the spillway chute.

The spillway alignment runs along the eastern embankment, outside toe and discharges directly into the Ohau River downstream of the proposed intake.

Under normal conditions the reservoir water will be directed through pipework from the reservoir to the water treatment plant (WTP). Therefore, only in very rare circumstances will there be discharges in the spillway chute allowing water to return to the Ohau River. Such events include:

- Reservoir levels raising above the maximum level (and thereby entering the spillway) due to extreme rainfall events. The catchment area for the reservoir is essentially the reservoir surface area and embankment with a minor upgradient catchment that could run on to the spillway in heavy rainfall events. Normally, rainfall on the reservoir would be captured within the stored water and would not initiate a spillway discharge. However, if the reservoir level is at or near full prior to the rainfall event, then a spillway discharge could occur. In this instance the discharge water quality would consist of a mixture of stored river water and rainfall.
- Overflowing of the reservoir level in the event of a failure of the pumping and control system resulting in over-abstraction of the river water (ie reservoir is full but abstraction system continues to operate). This scenario would be very infrequent and would be intercepted and ceased via appropriate alarming to the operator and subsequent operator initiated corrective action. Any discharge would be river water returned direct to the river.
- Water levels in the reservoir can be lowered through the low-level outlet and discharged to the lower portion of the spillway. This low-level discharge is only likely to the used for the irregular and rare maintenance of the internal faces of the reservoir; to ensure adequate turn-over of the stored water (although this will normally be achieved by supplying water to the water treatment plant); or to allow for inspection following a large earthquake. In general, when routine or planned maintenance is required and sufficient lead-time is available, drawdown would be achieved by use of water from the reservoir to supply the community, rather than via discharge to the river.

The quality of the water discharged into the Ohau River is unlikely to differ greatly from the original Ohau River source water. Measures to mitigate adverse changes in the water quality include sediment control sumps at the river intake which are intended to minimise sediment intake and operational procedures to promote mixing of the water throughout the water column and reduce the possibility of dead water and oxygen depletion. During detailed design of the reservoir, measures to protect the quality of the stored water will be considered further. Note that it is the applicant's best interests, as water supplier, to ensure that the reservoir is designed and operated in a way which does result in significant deterioration of water quality within the reservoir.

4.5 Pipeline Bridge

The proposed pipe bridge will be a single span bridge and there will be no piers in the river. It will be located immediately upstream of the existing road bridge and at the same level (or slightly higher) as the bridge deck to ensure that it does not have any effect on the flood carrying capacity of the river. The bridge will be designed for appropriate seismic loading and to be flexible in the event of an earthquake given that it needs to span the Northern Ōhāriu Fault. As described in the feasibility design report, the fault in this location is a right lateral strike slip fault which suggests that movement is expected to be along the line of the fault with little vertical displacement.

On each abutment, reinforced concrete piles will be required to be installed. The bridge options being considered are shown in Figure 4.9.

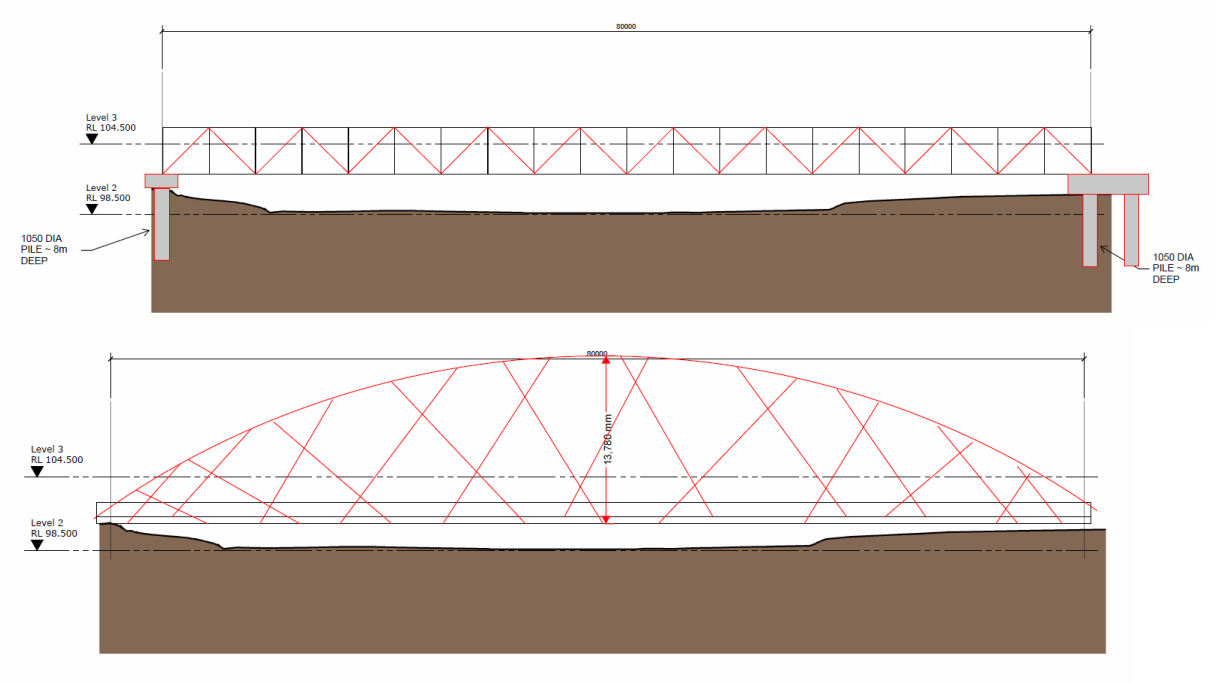


Figure 4.9: Pipe Bridge Options
Source: Figure 31 of Feasibility Design Report, Appendix B

4.6 Cultural and Ecological Restoration Area

Cultural and ecological restoration of the lower floodplain terrace is included in the proposal. As discussed in Section 7, Muaūpoko Tribal Authority's Cultural Impact Assessment identified that *"the proposed quantum of water taken from the Ohau Awa, especially at low flow will affect the mauri of the awa, other waterbodies and groundwater that are hydraulically connected to it. The impact on mauri will have adverse effects on Muaūpoko values which must be managed, positive actions must be undertaken to enhance the mauri of the Ohau Awa to offset for the effects the water take will have."* MTA recommended that a Cultural Offsetting Management Plan (COMP) be prepared and implemented, the objective of which would be to demonstrate how no net loss, and preferably a net gain, of mauri in the Ohau Awa and habitat availability are achieved through the implementation of offset activities.

MTA advisors and HDC have since worked together to assess and identify potential areas for offsetting activities and identified the lower floodplain terrace at the reservoir site provided "the greatest opportunity for net gain in mauri and habitat". A draft COMP has been prepared and included in this application in Appendix L. This identifies the following cultural offsetting and restoration activities to be undertaken on the lower floodplain terrace of the site.

- **Management Area 1: Stream Enhancement**. This is the stream at the base of the embankment. Restoration approach should include early / immediate removal of stock from the stream (to prevent further siltation of bed) and removal of litter; development and implementation of a planting and restoration plan, ensuring good connectivity to Ohau awa main stem is maintained.
- **Management Area 2: Wetland Creation / Restoration**. This area currently includes a straight, artificial drainage channel which connects with the upper portion of the stream from Management Area 1. The channel here is eroded, primarily as a consequence of stock access. This is the area where the under-drainage from the proposed reservoir is intended to discharge diverted groundwater to land. There is an opportunity here to create a restored wetland area through stock exclusion, contouring of the eroded banks, utilisation of the diverted groundwater to maintain desired hydrology, and planting of wetland species. Development of the restoration plan for this area should be undertaken in parallel with the detailed design of the under-drainage system for the reservoir.
- **Management Area 3: Weed Control, Stock Removal and Passive Restoration.** This area is the majority of the floodplain terrace which is currently grazed pastureland. This area provides an opportunity for passive restoration through weed control to manage invasive weed species; stock removal and manuka planting to establish vegetation cover and provide suitable conditions for passive restoration utilising the in-situ soil seed bank and natural transfer of seeds by birds. There are several log piles across this area. It is recommended that these be left in place to provide habitat (eg for lizards).
- **Management Area 4: Gravel Bed Habitat & Passive Restoration.** This is the lower floodplain terrace and active riverbed. A passive restoration approach is likely to be most suitable in this area and further assessment and advice is required as to the habitat type and restoration objective. Consent conditions are proposed to enable this approach. On the vegetated areas, a restoration approach using species such as manuka and harakeke may be appropriate. On gravel bed areas, weed control is required to prevent loss of the gravel bed habitat. As this is within the active river corridor, consultation with Horizons Rivers Management Team is required for activities in this area.

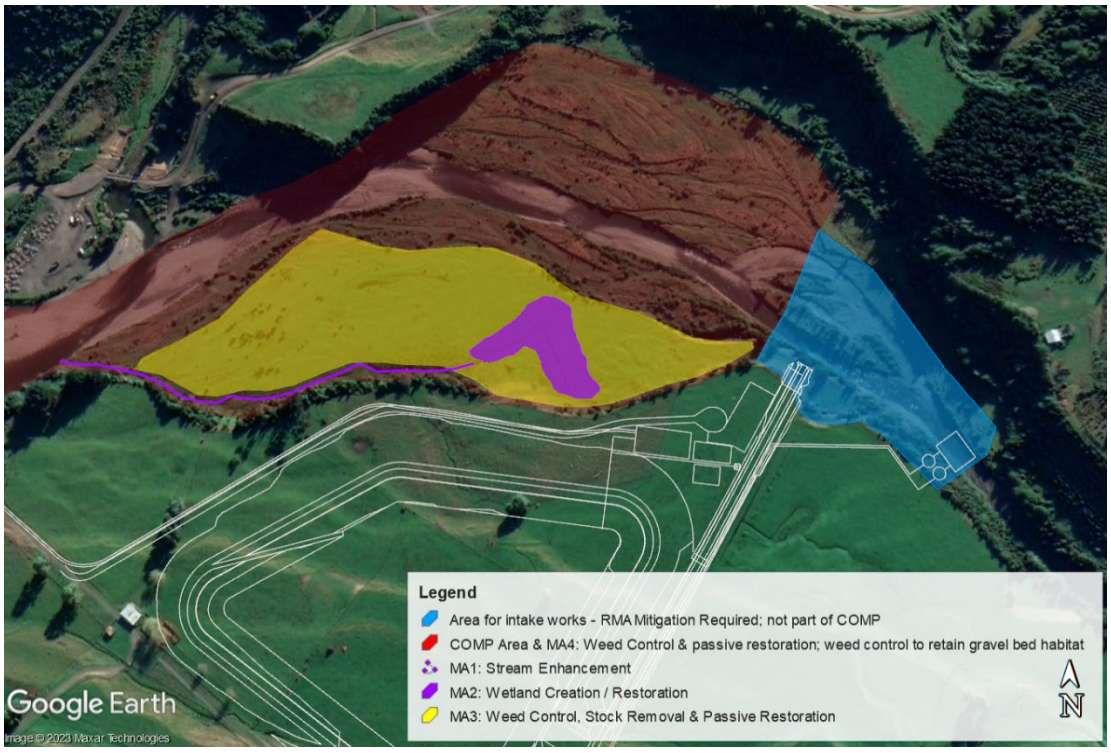


Figure 4.10: COMP Management Areas
Source: Figure 6 of draft COMP

HDC is continuing to engage with Raukawa hapū to seek their input into the cultural restoration proposal, and to further develop and refine the suite of conditions currently offered (refer section 10) and will continue to do so during the consenting process.

4.7 Proposed Intake for Ō2NL Project Construction Purposes

The location of the proposed intake for the abstraction of water to support the Ō2NL Project's construction is the stretch of river immediately upstream and downstream of the proposed bridge across the Ohau, as shown in Figure 4.11. The water abstraction limits sought have been detailed above. The following describes the physical intake arrangements proposed.

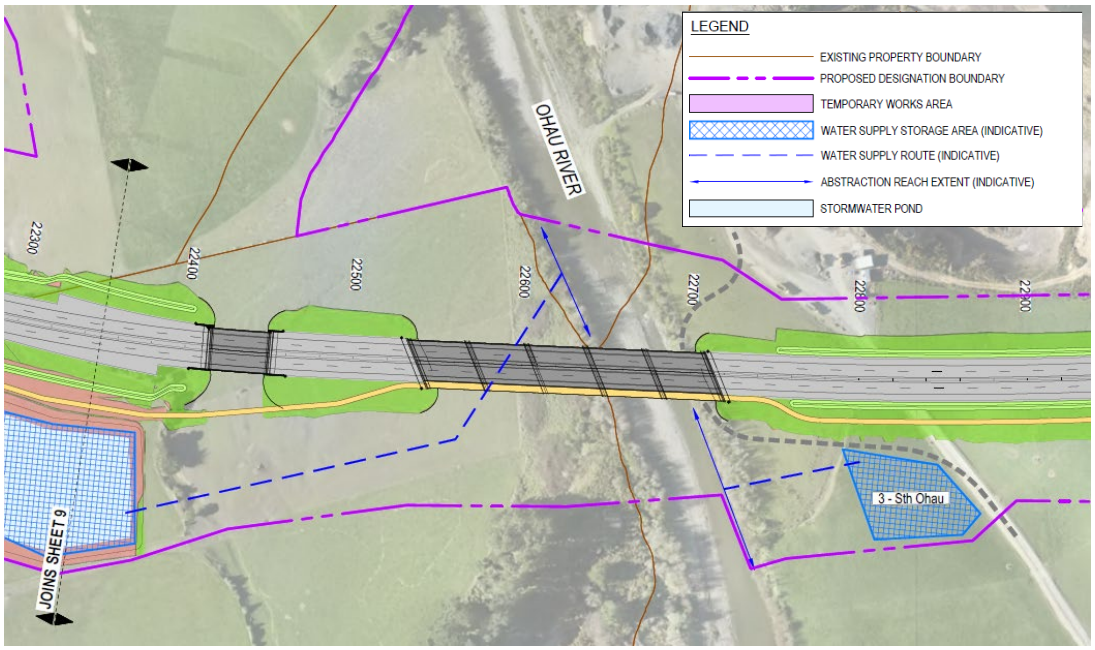


Figure 4.11: Abstraction Location for Ō2NL Project Construction Water

Water will either be abstracted by way of a screened surface intake pipe laid in the flowing water, or via a shallow bore located outside of the active river channel but within the riverbed as defined under the RMA. The final selection of the intake arrangements will be determined closer to the commencement of construction works and depending on construction methodology. For the purpose of this application, both potential intake arrangements are discussed as follows.

- **Option A: Surface Intake Pipe**
  This would be a pipe laid on the surface and with the intake within the flowing channel. The intake pipework would not need to be fixed to the riverbed and would be laid across the surface with a screened intake at the end which will be submerged within the flowing channel. The location of the intake would likely need to be adjusted during the construction period in response to changes in water course conditions, albeit any adjustment would be within the abstraction reaches shown in Figure 4.11. The intake screen will have a mesh aperture size not exceeding 3mm in diameter and an intake velocity of less than 0.3 m/s.

- **Option B: Shallow Bores**
  If the shallow bore option is used, this would be generally as shown in Figure 4.12 below. Two bores would be installed: one on the true right side of the river immediately upstream of the proposed Ō2NL Project's Ohau bridge to feed water to the northern storage pond, and one on the true left side of the river immediately downstream of the proposed Ō2NL Project's Ohau bridge to feed water to the southern storage pond (refer Figure 4.11). They would be located at least 10 m from the active channel area and would be installed such that they are not susceptible to overtopping in the 10-year flood event. The bore depth will be shallow (<10m) in order to abstract

water from the gravels below the riverbed, noting that this is still classified as a surface water abstraction. This form of abstraction avoids the need for any infrastructure in the channel and therefore no pipe or intake screen with mesh will be required.



Figure 4.12: Shallow Bore Typical Arrangement

In addition to the intake arrangements themselves, both options require surface pumps, generators and associated infrastructure (pipes) to be located within the riverbed, albeit outside of the active channel. Pumping equipment will be installed outside of the live channel of the river, and at locations that minimise effects on vegetation. Some minor earthworks and ground stabilising / concrete works may be required to create platforms for pumps and generators. The pumps will be located so that they are able to withstand up to a 10-year flood event and will be located at least 10m (horizontally) from the river. There are no wetlands in the vicinity of the intake sites. Generators will be located at least 20 metres from the water course and will be located within a containment bund. Pipes from the pump to the water course will be laid above ground and so that effects on vegetation are generally anticipated to be avoided but, in some instances, trimming of vegetation may be required.

5 KEY STATUTORY POLICY DRIVERS

The proposal has been developed using the key policy direction relevant to the activity as drivers. This approach recognises that there is significant statutory and policy direction provided to the Applicant across a range of legislation. The overall proposal, the abstraction regime sought and the mitigation measures offered have been shaped via consideration of these drivers. This section summaries these key statutory and policy drivers.

Horowhenua District Council has legislative obligations relating to the provision of safe drinking water as follows:

- Local Government Act 2002, which requires the Council to continue to provide water services and maintain its capacity to do so (s130).
- Water Services Act 2021 which places a duty on the Council to ensure safe drinking water is provided, and that sufficient quantity of drinking water is provided. The Water Services Act also requires the Council to give effect to Te Mana o te Wai.

These obligations are the primary drivers for the Levin Water Supply project and the need for this consent application. There are also a number of key national, regional and local statutory policy

provisions that have been considered and provided for in the development of the proposal. These include the requirements of the National Policy Statement for Freshwater Management and particularly the requirement to give effect to te mana o te wai; the National Policy Statement on Urban Development 2020 (NPSUD20) and the need to provide sufficient development to meet expected demand for housing and business land; requirements under the One Plan (Regional Policy Statement) for strategically planned infrastructure; and the 'reasonable and justifiable need for water' requirement as set out in the One Plan (Regional Policy Statement).

Additional specific policy considerations and assessments are included in a later section of the application to inform the section 104 RMA assessment of the proposal. The section 104D 'gateway test' assessment is included in this early section of the Application in order to provide assurance to the decision maker that there is no impediment to granting consent to the application in this regard.

5.1 Climate Change Resilience

Section 7 of the RMA requires particular regard to be had to, amongst other things, the effects of climate change. The National Climate Change Risk Assessment for New Zealand (Ministry for the Environment, August 2020) provides a national overview of how New Zealand may be affected by climate change related hazards and identifies the most significant risk and opportunities. It identified that "risks to potable water supplies (availability and quality) due to change in rainfall, temperature, drought, extreme weather events and ongoing sea-level rise" were 'Extreme' and these risks to potable water supplies had the highest urgency rating of all identified risks in terms of the urgency to take action to address the risk.

Horizons Regional Council's Regional Climate Change Risk Assessment (September 2021) was undertaken following on from the national risk assessment. The regional risk assessment identified that risks to water supplies from drought range from high at present to extreme by 2100, with risks from inland flooding and higher temperatures increasing from low at present to high by 2100. For the Horowhenua District, the regional risk assessment identifies that the district is "dependent on surface water takes for water supply and is particularly vulnerable to drought" and that districts that rely solely on one water supply source such as Horowhenua have an increased sensitivity to drought.

The regional risk assessment identifies that the *"adaptive capacity of water supply sources within the region will rely on the maintenance / enhancement of storage and the ability to manage water demand levels - particularly in areas such as … Levin where development and growth is occurring"*. The proposed reservoir and the ability to harvest water for storage (as will be enabled by grant of the reservoir and intake construction and abstraction framework sought) is therefore a critical step in addressing the high-extreme risks of climate change faced by the District and is consistent with, and gives effect to, the adaptive approach identified in the regional risk assessment.

5.2 Giving Effect to Te Mana o Te Wai

Te Mana o te Wai has been introduced into national regulation and policy as a fundamental concept for the management of freshwater in Aotearoa New Zealand. The National Policy Statement for Freshwater Management (NSPFM) requires that freshwater is managed in a way that gives effect to Te Mana o te Wai. The Water Services Act 2021 requires the Council, as a water supplier, to give effect to Te Mana o te Wai when it exercises its powers and performs its duties under the Water Services Act. Te Mana o te Wai is defined in NPSFM as follows:

> *"(1) Te Mana o te Wai is 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.*

(2) Te Mana o te Wai is relevant to all freshwater management and not just to the specific aspects of freshwater management referred to in this National Policy Statement"

Further, the NPSFM states that Te Mana o te Wai encompasses six principles relating to the roles of iwi / hapū and other New Zealanders in the management of freshwater:



Figure 5.1: Te Mana o te Wai Principles

One aspect of giving effect to Te Mana o te Wai is giving it practical definition at a regional level and accordingly incorporating and providing for it within regional plans by way of the Freshwater Planning Process. But in addition to this, there are clear rights (power and authority) given to iwi/hapū, along with responsibilities and obligations placed on decision makers and all New Zealanders, by way of the principles above. Hence, it is important that individual proposals that affect freshwater give effect to these principles.

Table 5.1: Giving Effect to Te Mana o te Wai

Principle	How is this principle given effect to within the Levin Water Supply Project?
Mana whakahaere	Clear recognition of Council's Tiriti partners; iterative process of engagement with iwi/hapū throughout development of proposal.
Kaitiakitanga	Undertaking of cultural values and impact assessment where desired and provision of input into the proposal, with opportunity for on-going input throughout the term of consent sought via the proposed conditions which require engagement with iwi and hapū in the construction and operation of the system.
Manaakitanga	Recognition of this process by the Applicant in ensuring that iwi/hapū are able to express manaakitanga where and when desired.
Governance	Council as Applicant and drinking water supplier recognising its role in making decisions about a new water supply source for Levin - optioneering to find a source and methods of extraction, treatment and delivery that prioritise the health and well being of the Ohau River now and over the life of the consents sought.
Stewardship	Council as Applicant and drinking water supplier ensuring, in conjunction with developing a robust and environmentally sensitive new supply for Levin, that its water conservation and demand management strategies and actions are also reviewed and developed further.
Care and respect	Council recognises its role in helping to educate and support its community in treating public water supplies and source waters with respect and managing their own use of water responsibly and with future generations in mind. Council as Applicant also recognises that in developing this proposal, it has a particular obligation to care and respect for source waters and freshwater resources.

The proposal has also been developed with particular regard to the hierarchy of obligations set out in the objective of the NPSFM. In the first instance, a source has been identified that is possible to take from without having more than minor adverse effects, and thus prioritising the health and well being of water bodies and freshwater ecosystems and recognising and providing for the intrinsic values of water. Further, the operating framework for the new supply minimises adverse environmental effects whilst also providing primarily for the 'second tier' of Te Mana o te Wai, being the health needs of people. The Applicant recognises that the times of extreme drought are also when the effect of the take on the Ohau River would be most significant and hence the times when that take is needed are minimised as far as possible. Council recognises that the supply also contributes to the third tier/priority, being the ability of people and communities to provide for their social, economic and cultural well-being, now and into the future. The proposal has been developed to reflect and give effect to the cascade or hierarchy of priorities within the NPSFM and to give effect to Te Mana o te Wai.

5.3 Regional Water Take Provisions and Allocation Regime

The Regional Plan water quantity framework provides a core allocation regime which is the primary regime under which the Levin Water Supply take is enabled and operates. There is no new core allocation being sought by way of this Application. Additionally, the Regional Policy Statement, at Policy LF-FW-P20 provides for supplementary allocation and Policy LF-TUD-P14 of the Regional Plan requires the consideration of opportunities for water storage and water harvesting. This policy pathway has been a key consideration in the development of the proposal and ensuring that the proposed option to increase resilience within the network and reduce effects on the River is one that is consistent with, and in fact enabled by, the Regional Planning framework for water management.

5.4 Regionally Significant Infrastructure and Strategic Integration of Infrastructure with Land Use

There are two key infrastructure objectives of the One Plan (Regional Policy Statement) that have been considered in the development of this proposal, including the need to develop the proposal and seek consent at this time, given the extent of residentially zoned land now available for development within the supply area. These objectives are considered to require the Applicant and consent authority to enable the activities proposed (Emphasis added):

> *RPS Objective EIT-01: Have regard to the benefits of infrastructure and other physical resources of regional or national importance by recognising and providing for their establishment, operation, maintenance and upgrading.*
>
> *RPS Objective UFD-01: Strategic Planning and Urban development*
>
> *Strategic planning for urban development ensures that:*
>
> *(1) sufficient development capacity and land supply for housing and business uses is provided to support growth,*
>
> ***(2) new development, development infrastructure and additional infrastructure are provided in a coordinated, integrated and efficient manner,***
>
> *(3) the diverse and changing needs of people, communities, and future generations are provided for through quality, sustainable urban form, and*
>
> *(4) competitive land and development markets are supported in ways which improve housing affordability.*

The activities proposed within this application are for the purpose of providing drinking water supply to Levin and for providing resilience within the existing network, to support strategic growth initiatives that have been or are being undertaken by Horowhenua District Council. Levin is the largest urban

centre within the Horowhenua District, and is the 10th fastest growing district in the country[22]. As per RPS Policy EIT-P1(1)(i), its water supply is infrastructure of regional or national importance. Hence, subject to the relevant assessment of effects, as addressed in another section of this application, including the 'reasonable and justifiable need' test required by the RPS, it is considered that the proposal is one that accords with the intent and policy provisions of the RPS for infrastructure and urban development.

5.5 National Policy Statement on Urban Development 2020

The urban environment in Levin is classified as a tier 3 urban environment under the NPSUD20. With the exception of removing car parking requirements from the district plan, the other requirements for a tier 3 urban environment are less prescriptive than for tier 1 and 2 environments. However, Clause 1.5 of the NPSUD states that tier 3 local authorities are:

> *"strongly encouraged to do the things that tier 1 or 2 local authorities are obliged to do under Parts 2 and 3 of this National Policy Statement, adopting whatever modifications to the National Policy Statement are necessary or helpful to enable them to do so"*

Horowhenua District Council has undertaken a number of strategic growth and development initiatives within Levin, including for example the Taraika plan change which rezones 420 hectares of land for approximately 3,500 new houses to be built and is based on the Taraika master plan and feeds into the Horowhenua Growth Strategy 2040. This work accords with the objectives of the NPSUD.

Further and more specifically, the Applicant is obliged under Policy 2 of the NPSUD20 to:

> *"at all times, provide at least sufficient development capacity to meet expected demand for housing and for business land over the short term, medium term, and long term".*

The NPSUD (clause 3.2) defines "sufficient development capacity" to include being "infrastructure-ready". As discussed earlier in this AEE (section 3.1.1), being 'infrastructure ready' is defined in clause 3.4(3) of the NPSUD to mean that there must be infrastructure in place to meet short term needs; infrastructure to meet medium term needs must have adequate funding in the Long-Term Plan if it is not already built; and infrastructure to meet long term needs must, as a minimum, be identified in the Council's Infrastructure Strategy. Further, clause 3.5 requires the Council to *"be satisfied that the additional infrastructure to service the development capacity is likely to be available"*.

The consents sought by way of this application are a critical component to Horowhenua District Council being able to meet its obligations under the NPSUD. They are necessary for Council to be satisfied that the additional infrastructure required to provide for sufficient development capacity will be available and that it will be able to provide municipal water supply to support well-planned growth in Levin.

5.6 Reasonable and Justifiable Need for Water

The Regional Policy Statement (Part 1 of the One Plan) includes policy LF-FW-P15 which defines what, for the purposes of allocation under the RMA, is considered to be "reasonable and justifiable" use of water. For public water supplies such as the Levin Water supply, this is defined as follows:

> *"a. an allocation of 300 litres per person per day for domestic needs, plus*
>
> *b. an allocation for commercial use equal to 20% of the total allocation for domestic needs, plus*

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[22] *https://www.horowhenua.govt.nz/News-Events/News/Horowhenua-now-the-10th-Fastest-Growing-District-in-New-Zealand#:~:text=The%20latest%20Census%20results%20for,Horizons%20and%20Greater%20Wellington%20regions.*

c. an allocation for industrial use calculated, where possible, in accordance with best management practices for water efficiency for that particular industry, plus

d. an allocation necessary for hospitals, other facilities providing medical treatment, marae, schools or other education facilities, New Zealand Defence Force facilities or correction facilities, plus

e. an allocation necessary for public amenity and recreational facilities such as gardens, parks, sports fields and swimming pools, plus

f. an allocation necessary to cater for the reasonable needs of animals or agricultural uses that are supplied by the public water supply system, plus

g. an allocation necessary to cater for growth, where urban growth of the municipality is provided for in an operative district plan for the area and is reasonably forecast, plus

h. an allocation for leakage equal to 15% of the total of (i) to (vii) above."

To support this application, an assessment of the current community use against Policy LF-FW-P15 has been undertaken and is included in Appendix C. The following provides a summary of that assessment.

In undertaking this assessment, it is important to note that the community has not yet been subject to individual metering of properties and connections and therefore there is no accurate metered data to characterise each of the separate elements of the Policy LF-FW-P15 assessment. The approach taken for this application has been to use the most accurate and representative data available, supplemented by industry standard measures where necessary, and to err on the side of under-estimation and to estimate the likely range of each of the elements. The assumptions made are detailed in the assessment included in Appendix C.

The Policy LF-FW-P15 assessment has found that:

- The present day 'reasonable and justifiable use' water assessment for the Levin public water supply under Policy LF-FW-P15 is estimated to be between 9,400 m^3/day and 9,700 m^3/day. As stated above, this estimate has been made using assumptions which are at the lower end of what uses may reasonably be considered to be connected to the supply in order to ensure that the policy LF-FW-P15 assessment is not over-stated[23].
- Since the existing consent was granted in 2017, the annual average water use for the supply has been between approximately 9,600 m^3/day. This is within the Policy LF-FW-P15 assessment stated above.
- Therefore, it is considered that the current use of water within the Levin Water supply scheme must be considered reasonable and justifiable under Policy LF-FW-P15 of the One Plan.

Given the current use is within the conservatively low estimate of policy LF-FW-P15 assessment of reasonable and justifiable use, it follows that the amount of water currently used by the community is reasonable and justifiable.

The ability to come to this conclusion has been a key driver in the development of the proposal, and particularly in terms of ensuring that the activities described in section 4.1 support and ensure that the take is reasonable and justifiable.

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[23] *For comparison purposes, evidence presented at the hearing for the existing water take consent assessed the policy 5-12 (now Policy LF-FW-P15) allowance as being 11,630 m^3/day. As stated, the assessment undertaken for this application has been to assume conservative low estimates so that there is a high degree of confidence that the policy LF-FW-P15 assessment is not overstated. Given that the current assessment is less than that previously assessed, this confirms that the policy LF-FW-P15 assessment is at least that of what has been estimated for this application.*

As noted above, the current community demand/water use is considered to be a reasonable and justifiable use of water as defined by the Regional Policy Statement. The Policy LF-FW-P15 methodology for assessing if a municipal public water supply use is reasonable and justifiable is driven by the number of persons served by the supply. Future water demands (as detailed in Appendix A) for the Levin water supply have been determined based on current use and current population and applying projected population growth rates. Given that the projection assumes, at worst, the same overall per capita water use for the system, and the current per capita water use is reasonable, it follows that the projected future water demand would also be reasonable and justifiable in accordance with Policy LF-FW-P15.

5.7 Section 104D RMA Gateway Test Assessment

The Application falls to be considered as a non-complying activity under the One Plan, and therefore the consent authority must not grant consent unless it is satisfied that either the adverse effects of the activity on the environment (other than any effect on a person who has given written approval to the application) will be minor or the application will not be contrary to the objectives and policies of the One Plan.

A complete s104D assessment is provided in section 12.1 of this AEE. The overall findings of the S104D assessment are summarised here in order to provide context and introduction to the subsequent sections of this AEE:

- The Applicant considers that the adverse effects on the environment will be minor, for reasons as set out in Section 9 of this AEE.
- The Applicant further considers that the Application very clearly is not contrary to the objectives and policies of the One Plan. Rather, it is considered that the proposal is one that the One Plan seeks to enable, particularly through the ability to provide supplementary allocation as per Policy LF-FW-P20 of the Regional Policy Statement and encouragement of the use of alternative sources of water including water harvesting and water storage as per Policy LF-TUD-P14 of the Regional Plan. This is in addition to the provisions discussed above relating to climate change resilience, giving effect to Te Mana o te Wai and regionally significant infrastructure and reasonable and justifiable use of water. A fulsome detailed assessment of all relevant objectives and policies of both the Regional Policy Statement and the Regional Plan is included in a later section of this Application, demonstrating that there are no provisions with which the proposal is contrary.

It is considered that there is no section 104D RMA reason that consent to the application cannot be granted and that the Application clearly meets both 'gateway tests' for non-complying activities.

6 ALTERNATIVES AND OPTIONS CONSIDERED

This section sets out the alternatives which have been considered in arriving at the proposal for which consent is now sought. It is structured in two parts. Firstly, alternatives are presented at a macro level being options to supplement the existing Levin Water supply to reduce effects on the river, provide for growth and improve scheme resilience. That alternative consideration determined that water harvesting and off-river storage was the best option for achieving the project objectives.

The second part considers the design options which have been considered in arriving at the proposal in this application, including options for intake location and design configuration as well as options for reservoir layout and configuration.

6.1 Water Supply Alternatives

The Applicant has undertaken detailed consideration and analysis of options for how to provide Levin with increased water supply given growth projections, as well as supply system options. This work is

set out in the Levin Water Supply - Water Supply Augmentation Operational Framework report dated March 2023, R3 and included at Appendix A. Consideration of the ability to provide drinking water supply to the townships of Ohau and Waitārere Beach is also provided therein and the Applicant seeks to be able to do so within the lifetime of the water take permit sought.

The options considered are shown in Figure 6.1.

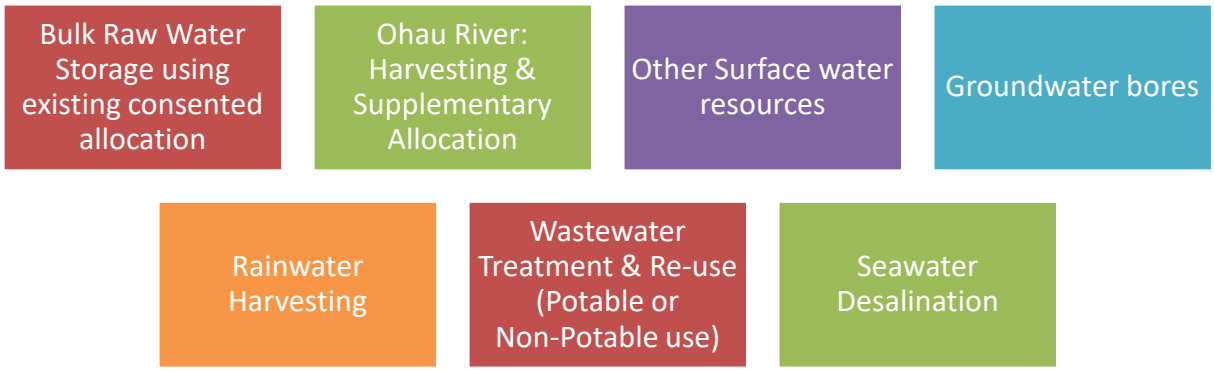


Figure 6.1: Options Identified for Assessment

These options are described and assessed in the report in Appendix A.

Each of the options was assessed using a multi-criteria traffic light assessment approach, with the assessment criteria and scoring approach as set out in Table 6.1.

Table 6.1: Assessment Criteria

Criteria	Assessment Guidance		
	Green	**Orange**	**Red**
Availability of Water: Is there sufficient water to meet projected needs for Levin?	Sufficient to meet demand to 50 or more years	Meets demand in the 10-50 year range	Does not meet demand in 10 year range
Cultural Values: Ability of the option to meet expectations of iwi / hapū and to give effect to Te Mana o te Wai.	Considered to give effect to Te Mana o te Wai and may be acceptable.	Contrary to tikanga and Te Ao Māori but may be acceptable with significant mitigations.	Considered to be culturally unacceptable.
Supply Resilience: Does it provide an alternative source of water not subject to the same risks as the Ohau River source? Does it provide storage for emergency purposes?	Significant improvement in supply resilience.	Improves resilience but some key risks remain.	Does not improve supply resilience.
Environmental: Is there potential for significant adverse effects?	Expected to be able to design and implement option such that effects will be less than minor; potential for enhancements to occur.	Potential for some adverse effects, but these are likely able to be mitigated.	Significant adverse effects likely

Criteria	Assessment Guidance		
	Green	**Orange**	**Red**
Source Water Suitability: Does the option change the risk profile associated with the source water (in terms of obligations for source water risk management under the Water Services Act)	Potential reduction in source water risks.	Similar to existing.	Significance increase in source water risks and / or complexity of source water risk management.
Economics: Capital and Operating Costs relative to other options.	Low costs - similar to existing system.	Options with mid-range of costs, when compared to other options.	Option with the highest capital and operating costs compared to others.

The key points from the assessment of each of the options were:

- **Bulk Water Storage using Existing Consented Allocation:** This option is similar to the proposal in this application but did not include seeking any additional water allocation. That is, it did not include the supplementary allocation that is now sought. It was found that a reservoir reliant on the existing consented allocation can only assist in meeting the community's needs through to between 2030 and 2036. After this, the annual demand would exceed that which is available under the existing consent and additional consented water source would be needed to fill the reservoir.
- **Ohau River: Harvesting & Supplementary Allocation:** This was found to be the preferred option and is as set out in this application. It was found to be the preferred option as it scored highest in the MCA analysis described above, being assessed as 'green' for all assessment criteria except for economic criteria in which it scored in the orange range. No options scored green in the economics category. That is, the preferred option scored in the highest range for all assessment criteria. The determination of this option was confirmed in the peer review of the options report as discussed at the end of this section.
- **Other Surface Water Resources:** There are only four other surface water resources in the area that could possibly provide sufficient water to assist to meet the community's future water demands. These are the Waikawa, Upper Mangahao, Tokomaru and Manawatū Rivers. The Upper Mangahao is not considered feasible as it would transfer water from the eastern catchment to the western catchment of the Tararua Ranges. This is likely to be culturally and environmentally unacceptable. The Tokomaru River could provide good quality water that is known to be suitable for drinking water (given the Tokomaru water supply comes from the same source) but would require 30+ km of new supply pipeline. Further, it was understood by the Applicant that there are significant cultural concerns with transfer of water between catchments that would need to be understood and addressed before this option was considered further. The Manawatū River is not recommended because of water quality concerns as well as significant conveyance costs (30+ km of pipeline). There are also similar concerns regarding the transfer of water between catchments. The Waikawa Stream may be a viable source. If it were to be pursued, bulk storage would also need to be developed to meet community needs beyond 2034. Conveyance routes are 15-20km. Likely cultural concerns regarding transfer of water between catchments, as well as water quality issues, would need to be assessed in the first instance to determine if this is a viable option.

  Further, these rivers are likely to be subject to the same climatic variability as the Ohau River and potential periods where abstraction would be restricted are likely to be experienced more frequently and more persistently compared to the Ohau River.

- **Groundwater Bores:** This was not pursued due to likely adverse effects on Lake Horowhenua. While groundwater could provide an alternative source of water, further investigation of groundwater quantity and, in particular, the interaction with and effect on Lake Horowhenua would need to be fully investigated and assessed. **Based on the information currently available indicating existing groundwater abstraction is having an adverse effect on the Lake, and noting that the shortfall in water supply required to meet Levin's demands would require abstraction an order of magnitude greater than the existing groundwater allocation, it is likely that this option would have an adverse effect on Lake Horowhenua.**
- **Rainwater Harvesting:** Rainwater tanks, if widely adopted, could reduce the overall annual demand on the water supply scheme, and their use is to be encouraged. **Council is doing this by requiring rainwater tanks in new houses in growth areas such as the Taraika Area.** However, rainwater stored on individual properties is expected to be used within the initial stages of an extended dry weather / peak demand period. Therefore, they do not provide meaningful storage to reduce peak community demand. This means that, irrespective of their adoption, the community supply scheme, including treatment plant capacity, will need to meet the projected peak day demand. **Rainwater tanks therefore assist in ensuring sustainable use of water and reducing demand. They are being encouraged and in some places mandated by Council, but they are not, by themselves, a solution to meeting the community's needs.**
- **Wastewater Treatment & Re-Use (Potable or Non-Potable Use):**
  - Wastewater treatment and re-use for drinking water purposes is generally considered unacceptable by iwi/hapū and by the general community. Potable re-use may be considered a viable option in the future, however, at this stage it is considered that it should not be pursued in recognition of likely opposition to the concept, costs and timeframes required to progress such an option.
  - For non-potable re-use, the option would either involve reuse of treated wastewater by large water users who do not need potable water quality and / or reticulation of treated wastewater to households for non-potable uses via a new reticulation network dedicated for this purpose.

    In terms of large water users, these are typically open spaces such as reserves, parks or golf course irrigation or industrial uses which do not need drinking water quality water. This may have a benefit in reducing wastewater volume discharges, but from a water supply perspective, this option only has benefits if these users currently source their water from the community water supply which, in the case of Levin, they do not. Further, large industrial uses connected to the supply are involved in the food sector and require drinking water quality water supply.
  - Treated wastewater to a level sufficient for outdoor non-potable use and making this available to the community would require a new reticulation system dedicated to this purpose. If made available to the entire community, this would likely mirror the existing water reticulation network with significant capital and operational costs. Operational and risk management practices would also need to be in place to prevent the treated wastewater being used for potable purposes.
- **Seawater Desalination:** This option was not considered in detail due to the likely significant capital and operating costs, likely long-lead timeframes for implementation, and that this technology is not currently adopted in New Zealand.

Table 6.2 shows how these options were assessed in accordance with the criteria set out in Table 6.1. Refer to the options report in Appendix A for more details.

Table 6.2: Assessment of Options and Overall Ranking. (Assumes all criteria have equal weighting)

	Availability of Water	Cultural Values	Supply Resilience	Environmental Considerations	Source Water Suitability	Economics: Capital and operating costs	Score	Ranking
Bulk Raw Water Storage Using Existing Consented Allocation							22	3
Ohau River Water Harvesting (Reservoir) + Supplementary Allocation							28	1
Other Surface Water Resource: Waikawa Stream							16	5
Other Surface Water Resource: Upper Mangahao							14	8
Other Surface Water Resource: Tokomaru River							14	8
Other Surface Water Resource: Manawatu River							14	8
Groundwater Bores							14	8
Rainwater Harvesting							24	2
Wastewater Treatment & Re-use: Potable Reuse							14	8
Wastewater Treatment & Re-use: Bulk non-potable							16	5
Wastewater Treatment & Re-use: Reticulated non-potable							14	8
Seawater Desalination							16	5

The options assessment found that:

- **The preferred option is water harvesting when the Ohau River is above median flow (under the Supplementary Allocation provisions of the One Plan) and a Bulk Raw Water Storage Reservoir.**

Peer Review of Options Assessment

The Options Assessment has been peer reviewed by SLR Consulting Ltd (refer Appendix A). The peer review found that:

> *"The option of utilising additional water from the Ohau River, and off-river storage, allows all the risks and opportunities to be clearly identified and quantified to an acceptable level. This option is also likely to be the most cost effective and efficient solution to meeting increasing demand for potable water to support the Levin community.*
>
> *…*
>
> *The Levin community is going to need additional water supply in the future. While there is some uncertainty as to when this might occur, it will occur and therefore HDC need to be proactive. There is a considerable delay between planning, consenting, and commissioning a new or additional water supply. Therefore, proactive management of this issue is essential.*
>
> *The use of an off-river bulk raw water storage reservoir, and water harvesting when flow in the Ohau River exceeds the median, is in my opinion the most cost-effective, practical, and realistic option. These developments will be required irrespective of any leakage, pressure, or demand management. These additional strategies are likely to only delay the need for additional water supply and not avoid the need for additional water supply at some stage in the medium term."*

The peer review confirmed the findings of the options assessment that the option of water harvesting and off-river storage reservoir is the preferred option for reducing the effects on the river, meeting the community's needs and increasing the resilience of the scheme.

6.2 Alternatives & Options Within the Project

Having established the preferred option of water harvesting and off-river reservoir, there were a number of options within the overall proposal that are described in the Options Report (Appendix A) and the Feasibility Design Report (Appendix B). These are summarised below.

6.2.1 Reservoir Location

The options report considered options for where the reservoir could be located via a constraints mapping exercise (refer section 4.3, Appendix A). The constraints mapping identified sites large enough for the required reservoir volume that were upstream of the existing water intake to ensure appropriate source water quality and the reservoir intake remained within the reach of river valued for Water Supply purposes under the One Plan, as well as for efficiency of conveyance of water from the reservoir to the Treatment Plant. It then excluded areas which were subject to any Outstanding Natural Features, Landscape Areas or Important Ridgeline overlays in the District Plan. The constraints mapping also sought to avoid any known sties of cultural significance, known fault lines, floodplain areas and the National Grid Transmission Line.

The proposed site was one of the sites identified in the constraints mapping exercise and was purchased by Council on a willing buyer-willing seller basis.

In developing this application, a potential natural inland wetland of marginal classification was identified on the reservoir site. This required a reassessment of the other sites identified in the Options report to ensure that there is a functional need for the reservoir to be located on the proposed site. This assessment is detailed in the technical memo included in Appendix K which found that:

> *Of the three potential reservoir sites identified in the WSAOF, the proposed site is the only one which has sufficient land for the reservoir; has access to a suitable reservoir intake site on the Ohau River at the exit of the Conservation Estate which can provide sufficient water to fill the reservoir; and includes a suitable and sufficient area to enable mauri and habitat enhancement to offset the cultural effects of the abstraction.*

6.2.2 Intake Options

The existing intake is not of sufficient capacity to meet the required water abstraction rates, and therefore a new or upgraded intake is required. Three options were identified and assessed via a multi criteria analysis to identify the preferred intake location and configuration. These option and the multi criteria analysis are discussed in Section 8.2 of the Feasibility Design Report in Appendix B. In summary, the options were:

a. **A new intake upstream of the proposed reservoir, near the historic intake location.** The Levin water supply was first installed in the early 1900s with water sourced from a weir across the Ohau River approximately 1.2 km upstream of the reservoir site, where the river exits the Conservation Estate. The benefit of this site was that it would have high quality of source water due to its location in relation to the Conservation Estate (particularly given the One Plan requires the river in this area to be managed to meet its 'Natural State'), and would enable gravity conveyance of water from the river to the reservoir site. However, bedrock beneath the river meant that a sub-surface infiltration gallery would not be possible at this site and an above bed structure involving a weir, Coanda screen and fish passage structure would be required. Such a structure is obviously not ideal for fish passage considerations. Further, this option would require significant disturbance to vegetation (including areas of indigenous vegetation and riparian areas) for construction and operation access. The abstraction capacity of this option was also limited by the size of pipework required to convey the water to the reservoir.



Figure 6.2: Historic water supply weir across the Ohau River generally in location of Intake Option A (circa 1908, since decommissioned and removed)
Photo credit: Horowhenua Historical Society Inc. Photo looking downstream towards the weir

b. **Sub-surface infiltration gallery at or near the reservoir site. This is the preferred intake** option as detailed in Section 4.2. This site enables the use of a sub-surface infiltration gallery option so that, after construction, there are no impacts on fish passage. The river corridor in this area enables the river to be easily diverted around the construction site while remaining within the river corridor such that construction effects can be managed. Further, its close proximity to the reservoir site enables efficient pumping from the river to the storage reservoir.

c. **Upgrade the Existing Intake Site.** To achieve the capacity required, the existing intake (subsurface infiltration pipe) would need to be rebuilt and expanded significantly. This would require major disturbance to the river bed and cannot be done in the dry unless the river is diverted to a new temporary channel outside of the river corridor and on private land. Further, an additional temporary intake would be required to maintain water supply to the community during the construction period. This option also involves significant additional pumping costs, which has implications in terms of power usage and greenhouse gas emissions of the scheme, due to the need to pump the water for storage up to the reservoir site before pumping it back down to the treatment plant when needed.

6.2.3 Reservoir Configuration & Staging Consideration

A feasibility assessment for the proposed reservoir considered the option of one large reservoir or two smaller reservoirs at the site. This is discussed in Section 2 of the Feasibility Design Report in Appendix B.

Two smaller reservoirs on the site were considered as it was thought that this could provide some operational flexibility and may also allow for staging of the capital investment required (with one reservoir being constructed immediately, and the second at a later date). However, on analysis, it was found that the timeframe possible for staging was not sufficient to warrant a staged construction (i.e. the Council would need to start stage 2 very shortly after stage 1 was completed) and that the two reservoir option had more maintenance costs requirements without any commensurate benefit. Further, the two-reservoir option resulted in a significant reduction in the effective capacity of the storage. A single reservoir on the site will achieve in excess of 700,000 m^3 of effective storage, whereas two smaller reservoirs can only achieve a combined capacity of 462,000 m^3 due to the volume lost by the embankment between the two reservoirs.

Ultimately, it was found that "the single reservoir arrangement uses resources most efficiently in both the short and long-term".

6.3 Summary

In summary, the options assessment and its subsequent peer review found that the best option for meeting the Levin community's current and future needs, reducing effects on the river and improving scheme resilience was a water harvesting and storage scheme as proposed in this application.

The feasibility and preliminary design process has also confirmed through a series of multi-criteria analyses that the water harvesting scheme is most appropriately delivered through via the construction and use of a sub-surface infiltration gallery at the proposed reservoir intake site and a single large reservoir at the proposed Poads Road site.

7 TE TIRITI AND SECTION 8 RMA - PRE-LODGEMENT IWI ENGAGEMENT

Council has undertaken pre-lodgement engagement with Muaūpoko Tribal Authority and Ngāti Raukawa iwi and hapū. The following provides a brief summary of this engagement process. HDC will continue to engage with iwi and hapū throughout the consent process, design, construction and operation of the proposal.

Muaūpoko Tribal Authority

The Council has engaged with Muaūpoko Tribal Authority (MTA) throughout the development of the proposal and this assessment of environmental effects. HDC has in place a Memorandum of Partnership with MTA. In agreement with MTA, a Cultural Impact Assessment (CIA) was commissioned in 2022 and was developed based on a draft version of this AEE and site visits alongside HDC representatives. The CIA is included in Appendix F.

The CIA acknowledged "the partnership we [MTA] are creating with HDC and the journey ahead to fulfilling our agreement as Te Tiriti Partners".

The CIA identified that there is an adverse effect of the proposal, particularly the abstraction below minimum flow, on the mauri of the awa, and sought cultural effects offsetting proposals be developed and committed via consent conditions for a Cultural Offsetting Management Plan (COMP). HDC has worked with MTA to develop a COMP and has included that proposal within this application (refer Appendix L). HDC is committed to the implementation of the COMP noting its primary objective of ensuring no net loss, and preferably a net gain of mauri of the Ohau awa and habitat. While there are many ecological benefits of the proposed COMP initiatives, the COMP is first and foremost a means of addressing cultural effects of the proposal.

Te Rūnanga o Raukawa & hapū: Ngāti Tukorehe, Ngāti Kikopiri, Ngāti Hikitanga

At the commencement of the project (December 2021), HDC engaged with Te Rūnanga o Raukawa and sought guidance as to how best to engage including whether or not to engage via the Runanga or direct with hapū of the rohe. It was agreed that HDC would resource technical support for iwi / hapū to support this engagement and that the engagement may occur via hapū. At the request of Te Tūmatakahuki, HDC resourced Catalyst Group to support Te Tūmatakahuki (including Ngāti Kikopiri, Ngāti Hikitanga) in considering the project. HDC has also met with representatives of Ngati Tūkorehe and it has been agreed that the work being undertaken by Catalyst Group will also be shared with Ngati Tūkorehe to support their assessment of the proposal and understanding of cultural impacts.

HDC's project team has met on several occasions with Catalyst Group, including undertaking a site visit and a draft version of this AEE was provided to support the completion of a CIA. Catalyst provided a planning assessment of the draft application which identified some technical matters regarding the hydrology, planning and wetland assessment, all of which have been addressed in the final AEE. The Catalyst report was silent in terms of cultural values or effects except to note that "HDC has extended

an invitation to Te Tūmatakahuki to visit the site to assess its cultural significance. Any places of significance to Te Tūmatakahuki can be reflected in the hapū position on the proposed reservoir site".

HDC has held further hui with representatives of Ngāti Tūkorehe, Ngāti Kikopiri and Ngāti Hikitanga from August 2022 through to current date including a detailed project briefing hui and site visit in December 2023. HDC will continue to engage with Ngāti Tūkorehe, Ngāti Kikopiri, Ngāti Hikitanga as the project is developed post lodgement.

In addition to the above, representatives from MTA and Raukawa hapū have also been involved in several hui involving NZTA and HDC regarding the provision of water to enable construction of the Ō2NL Project via this consent application.

8 RULE FRAMEWORK ASSESSMENT

A summary of the resource consents sought for the proposed activities and the activity status of each component of the proposal is set out in section 2.3. The following sections provide the detailed assessment of relevant rules from which that summary has been derived.

Water take permit to abstract 16,159m^3/day from the Ohau River (being 15,409 m^3/day of consumptive take and 750 m^3/day of non-consumptive take) (Core Allocation)

The abstraction significantly exceeds the threshold for a minor take (being 15 m^3/property/day) of the One Plan and cannot be considered as a Permitted Activity under Rule LF-TUD-R39.

Rule LUF-TUD-R43 of the One Plan provides for 'Takes and Uses of Surface Water Complying with Core Allocations' as a Controlled Activity, however, this rule requires that there be no abstraction when the river is at or below its minimum flow. As the proposed activity includes abstraction below minimum flow prior to the reservoir construction; an exceptional circumstance abstraction when the river is at or below its minimum flow after the reservoir is operational; and a 750 m^3/day non-consumptive take which is required to continue below minimum flow, it cannot be considered as a Controlled Activity under Rule LUF-TUD-R43.

Rule LUF-TUD-43 provides for 'Existing essential takes and uses of surface water complying with core allocations taken at or below the minimum flow" as a Discretionary Activity provided that the amount of water taken does not exceed 250 L/person/day. The amount of water sought to be taken below minimum flow exceeds 250 L/person/day and therefore cannot be considered a Discretionary Activity under Rule LUF-TUD-43.

The Core Allocation component of the requested abstraction therefore falls to be considered as a **Non-Complying Activity under Rule LF-TUD-R47,** 'Takes and uses of surface water not complying with core allocations or takes and uses of water taken at or below minimum flow.'

Water take permit to abstract supplementary allocation to enable water harvesting at times when the Ohau River is above median flow and which, in total is not to exceed 10% of the actual flow in the river at the time of abstraction. (Supplementary Allocation)

Despite being provided for via the allocation framework and policies within the Regional Policy Statement (Part I of the One Plan), there are no rules within the Regional Plan specifically related to applications for supplementary allocation. By definition, the supplementary allocation is outside of the core allocation, and therefore the taking of water as supplementary allocation falls to be considered as a **Non-Complying Activity under Rule LF-TUD-R47**, 'Takes and uses of surface water not complying with core allocations or takes and uses of water taken at or below minimum flow.'

Land use (bed of river) consent to construct, operate and maintain a new water intake structure (infiltration gallery) for drinking water supply purposes including intermittent air backwash of the system

Rule LUF-AWBD-R54 of the One Plan provides for 'Structures and Disturbances involving a reach of river or its bed with RP-SCHED2 Values of Natural State, Sites of Significance - Aquatic and Sites of Significance - Cultural' as a Discretionary Activity. None of these values apply to the stretch of the river bed where the reservoir intake and riparian works will be undertaken. The activity is therefore not encompassed by Rule LUF-AWBD-R54.

Rule LF-AWBD-R64 provides for 'Other Structures including bridges, fords and other access structures' as a Permitted Activity. The infiltration gallery and associated riparian works is considered to be an 'other structure'. Criteria (3) of Rule LF-AWBD-R64 requires that all structures, whether in, on, under or over the bed of a river must occupy no more than 20 m^2. The proposed infiltration gallery will occupy over 1,200 m^2 of the river bed, albeit constructed under the river bed, and therefore cannot be undertaken as a Permitted Activity under Rule LF-AWBD-R64.

Rule LF-AWBD-R68 provides for 'Activities Affecting RP-SCHED2 Values of Flood Control and Drainage' as a Discretionary Activity. This value does not apply to the reach of the river in which the infiltration gallery will be constructed and therefore the activity is not encompassed by Rule LF-AWBD-R68.

The reservoir intake therefore falls to be considered as a **Discretionary Activity under Rule LF-AWBD-R76**, 'Activities that do not comply with permitted activity, controlled activity or restricted discretionary activity rules and all other s13(1) RMA activities not covered by this chapter'. The activities covered by this rule are activities requiring consent under s13(1) of the RMA and any ancillary excavation, drilling, tunnelling or other disturbance of the bed pursuant to s13(1) RMA and damming or diversion of water pursuant to s14(2) RMA; discharge of water or sediment into water or onto land pursuant to section 15(1) or 15(2A) RMA, and deposition of substances in or on the bed of the river pursuant to s13(1) RMA.

In terms of the vegetation clearance and earthworks required on the true left bank of the river in association with the construction of the new intake structure, the area affected is less than 2,500 m^2 and the activity is therefore encompassed by Rule LF-LAND-R1 which applies to 'small scale land disturbance'. The proposed activity cannot meet the requirement of that Rule that the land disturbance must not be within 5 metres of a river that is permanently flowing. Likewise, the activity cannot meet the same permitted activity standard for vegetation clearance as required by Rule LF-LAND-R5.

The ecological assessment undertaken for the proposed works at and near the reservoir intake site has confirmed that the affected area does not include any areas of at-risk, rare or threatened habitats and therefore it is not encompassed by Rules ECO-R1 or ECO-R2.

The vegetation clearance and earthworks adjacent to the river therefore fall to be considered as a **Discretionary Activity under Rule LF-LAND-R8** 'Vegetation clearance, land disturbance, cultivation or forestry that does not comply with Rules RP-LF-LAND-R1 to RP-LF-LAND-R7' and which are not regulated under Rules ECO-R1 or ECO-R2.

It is noted that in terms of the avoidance, remediation or mitigation of effects, the proposed disturbance of the river bed and the proposed land disturbance and vegetation clearance required for the intake structure are included in the Erosion and Sediment Control Plan required for the large scale earthworks for the reservoir construction, which is discussed below in relation to that activity.

Land use (bed of a river) consent to construct, operate and maintain a water pipe bridge over the Ohau River to convey water from the water storage reservoir to the drinking water treatment plant

Rule LUF-AWBD-R54 of the One Plan provides for 'Structures and Disturbances involving a reach of river or its bed with RP-SCHED2 Values of Natural State, Sites of Significance - Aquatic and Sites of Significance - Cultural' as a Discretionary Activity. The river is valued for Site of Significance - Aquatic at this location and an assessment of this rule is required. The Activity description of this rule for activities in Sites of Significance - Aquatic states:

(a) *The erection, placement or extension of any structure in, on, under or over the bed, except for lines, cables and ropeways that are suspended above the water and do not require a support structure in, on, over or under the bed and except for those activities regulated by Rule RP-LF-AWBD-R67.*

The proposed pipe bridge is to be constructed over the bed and does not require support structure in, on, over or under the bed. The proposed activity is therefore not encompassed by Rule LUF-AWBD-R54.

The activity is within a reach of the river with a RP-SCHED2 value of Flood Control and Drainage and assessment against Rules LF-AWBD-R67 and LF-AWBD-R68 is required. Rule LF-AWBD-R67 provides for activities to be undertaken as a Permitted Activity if they are undertaken by or on behalf of the Regional Council. This is not the case and therefore the activity cannot be undertaken as a Permitted Activity under rule LF-AWBD-R67.

Rule LF-AWBD-R68 provides for 'Activities affecting RP-SCHED2 Value of Flood Control and Drainage' as a Discretionary Activity and includes '(2) the erection, placement or extension of any building or other structure' where the activities are undertaken within the bed of a river and / or for areas without stopbanks, anywhere within 10 m of the bed of the river. The proposed pipe bridge activity is located in an area without stopbanks and is within 10 metres of the bed of the River and therefore falls to be considered as **Discretionary Activity under Rule LF-AWBD-R68**.

Land Use Consent for Large-Scale Land Disturbance (Earthworks) to construct the reservoir, spillway, access road and ancillary infrastructure at the reservoir site.

Rule LF-LAND-R1 provides for small-scale land disturbance of less than 2,500 m^2 per property per year as a Permitted Activity. The earthworks and land disturbance required to construct the reservoir covers an area of approximately 10 ha and therefore cannot be considered as a small-scale land disturbance activity under Rule LF-LAND-R1.

Rule LF-LAND-R6 provides for large-scale land disturbance, including earthworks, as a Controlled Activity. The Controlled Activity criteria are:

1. *The activity must not take place on land that is within a coastal foredune*
2. *The activity must be undertaken in accordance with an Erosion and Sediment Control Plan.*
3. *Any discharge of sediment must not, after reasonable mixing, cause the receiving water body to breach the water quality standard for visual clarity set out in RP-SCHED5 for that waterbody.*
4. *The activity must not occur on land that is in, or within 5 m of:*
    a. *The bed of a river that is permanently flowing*
    b. *The bed of a river that is not permanently flowing and has an active bed width greater than 1 m*
    c. *the bed of a lake.*
5. *The activity must not occur on land that is in, or within 10 m of:*

a. A wetland as identified in RP-SCHED6

b. Sites valued for Trout Spawning as identified in RP-SCHED2

c. Site of Significance - Aquatic as identified in RP-SCHED2

The proposed activity is not within a coastal foredune area. Except for the intake construction activities (assessed above) the reservoir earthworks are not within 5 m of a river or lake, nor are they in an area identified for trout spawning or site of significance-aquatic. The activity will be undertaken in accordance with an Erosion and Sediment Control Plan as described in Section 4.3, and provided in Appendix J. The erosion and sediment control measures proposed will ensure that the earthworks do not cause the visual clarify standards to be breached in the Ohau River. The ecological assessment has identified that there is a potential natural inland wetland of marginal classification within the earthworks footprint, however, that assessment (Appendix H) found that the potential wetland did not meet the criteria of RP-SCHED6.

Therefore, all of the criteria of Rule LF-LAND-R6 are met and the large-scale earthworks to construct the reservoir and associated infrastructure fall to be considered as a **Controlled Activity.**

National Environmental Standards for Freshwater(NES-FW) - Natural Inland Wetland Regulations Earthworks and Land Disturbance for Specified Infrastructure, within and within 100 m of a Natural Inland Wetland that will result in complete drainage of the Natural Inland Wetland

The ecological assessment has identified that there is a site within the reservoir footprint that could be classified as a natural inland wetland. As discussed above, this is considered to be a very marginal classification. Adopting a precautionary approach, this application has been prepared on the basis of this site being a Natural Inland Wetland under the NES-FW.

Regulation 45 of the NES-DW provides for the following activities:

(2) Earthworks or land disturbance within, or within a 10 m setback from, a natural inland wetland is a discretionary activity if it is for the purpose of constructing specified infrastructure.

(3) Earthworks or land disturbance outside a 10 m, but within a 100 m, setback from a natural inland wetland is a discretionary activity if it—

(a) is for the purpose of constructing specified infrastructure; and

(b) results, or is likely to result, in the complete or partial drainage of all or part of the natural inland wetland.

The proposed reservoir construction involves earthworks which are both within a natural inland wetland area and within a 100 m setback from a natural inland wetland and will result in the complete drainage of that natural inland wetland.

'Specified Infrastructure' in the NES-FW has the meaning given by the National Policy Statement for Freshwater Management. The NPSFM defines 'specified infrastructure' as follows:

Specified Infrastructure means any of the following: …

(c) any water storage infrastructure.

The reservoir clearly meets the definition of specified infrastructure and the earthworks and associated drainage of the possible natural inland wetland can be considered under Regulation 45 as a Discretionary Activity.

Clause (6) of Regulation 45 further states:

> *A resource consent for a discretionary activity under this regulation must not be granted unless the consent authority has first—*
>
> *(a) satisfied itself that the specified infrastructure will provide significant national or regional benefits; and*
>
> *(b) satisfied itself that there is a functional need for the specified infrastructure in that location; and*
>
> *(c) applied the effects management hierarchy.*

Under RPS Policy EIT-P1, the Levin water supply system is recognised as a physical resource of regional or national importance, and Regional Council is required to have regard to the benefits of the activity. Notwithstanding that the regional benefits of the proposal are self-evident under RPS Policy EIT-P1, the options assessment report has clearly identified that the reservoir is necessary to reduce adverse effects on the Ohau River; provide for the community growth; and to improve the resilience of the scheme, including to address climate change risks identified in national and regional risk assessment. The Regional Council can therefore be satisfied that the specified infrastructure will provide significant regional, if not national, benefits.

The Applicant has assessed the functional need for the reservoir to be constructed in the location proposed (refer Appendix K), and concluded as follows:

> *It has been demonstrated that there is a functional need for the 740,000 m^3 reservoir at Poads Road (Lot 9 DP 555714), as proposed by HDC and designed on a preliminary basis by Damwatch, as specified infrastructure in that location. This is because:*
>
> - *Of the three potential reservoir sites identified in the WSAOF, the proposed site is the only one which has sufficient land for the reservoir; has access to a suitable reservoir intake site on the Ohau River at the exit of the Conservation Estate which can provide sufficient water to fill the reservoir; and includes a suitable and sufficient area to enable mauri and habitat enhancement to offset the cultural effects of the abstraction.*
> - *If a smaller reservoir was to be constructed, such that the marginal natural inland wetland was avoided, there would still be a need to abstract from the river below minimum flow during drought events, and the reservoir would have a significantly reduced timeframe in which it could meet council's sought level of service of 30-days storage following emergency.*

The Regional Council can therefore be satisfied that there is a functional need for the specified infrastructure in that location.

The Effects Management Hierarchy has been applied as described in Section 9.5.3 and it is concluded that the proposed approach "would very substantially outweigh the minor adverse effects associated with the loss or modification of this small, highly modified 'marginal' wetland." (Wildlands report, Appendix H).

There is therefore no impediment to grant of consent under Regulation 54(6) of the NES-FW.

Planting and Restoration in and around a Rare Habitat

The proposed cultural effects offsetting measures include weed and litter removal and restoration planting in and around a rare habitat, being the watercourse on the lower floodplain terrace (Site 3 in the ecological assessment report). Planting and restoration are not regulated under the One Plan rules. However, there may be some associated vegetation clearance, land disturbance and other activities associated with the restoration works which are regulated under Rule ECO-R2 which provides

for "some activities within rare habitats and threatened habitats" as a Non-Complying Activity. Consent is therefore sought to be able to implement the proposed cultural offsetting management plan under Rule ECO-R2.

Discharges to, and Restoration of, Natural Inland Wetland Areas on the Lower Terrace (Cultural Offsetting Management Plan Area), National Environmental Standards for Freshwater

The ecological assessment report has identified three areas on the lower terrace within the proposed Cultural Offsetting Management Plan area which are classified as Natural Inland Wetlands under the NES-FW. Restoration works are proposed in and close to these areas as detailed in the COMP in Appendix L and described in Section 4.6 above. These works are being done for the purposes of natural inland wetland restoration and wetland maintenance and are required to mitigate and offset the cultural effects of the proposal including the water take from the Ohau River.

Regulation 38 of the NES-FW provides for the following activities as a Permitted Activity, where they are being undertaken for wetland restoration and maintenance purposes:

- Vegetation clearance within, or within 10 m setback of a natural inland wetland
- Earthworks or land disturbance within, or within 10 m setback of a natural inland wetland
- The taking, use, damming, diversion or discharge of water within or within 100 m setback from a natural inland wetland.

The above activities can only be undertaken as a Permitted Activity under Regulation 38 if they meet the relevant conditions of Regulation 38(4). An assessment of these conditions is set out below:

a. the activity must comply with the general conditions on natural inland wetland activities in regulation 55. The general conditions in regulation 55 are all able to be met, and the Applicant proposes a consent condition that requires that the final COMP include sufficient details to confirm to the Regional Council that the general conditions are met, and that this be provided to Regional Council prior to commencement of the COMP implementation works.

b. Vegetation clearance, earthworks and land disturbance must not exceed the lesser of 500 m^2 or 10% of the natural inland wetland area. No significant vegetation clearance, earthworks or land disturbance are proposed on the lower terrace, although some minor amounts may be required to implement the COMP. Any such activities will be for the purpose of planting or wetland restoration, or clearance of exotic species and are therefore exempted from the area restriction in accordance with regulation 38(5).

c. If the activity is the discharge of water, it must not be a restricted discretionary activity as described in regulation 39(3A). A discharge of water is proposed in this area, being the groundwater from under the reservoir footprint. Regulation 39(3A) is applicable if the discharge will enter the wetland. The discharge is proposed to enter the wetland area, as it will be used to ensure an appropriate hydrological regime for wetlands 3 and 4 identified in the ecological assessment report.

The above assessment has shown that any vegetation clearance, land disturbance and earthworks as well as any associated damming or diversion of water within the natural inland wetlands on the lower terrace, undertaken to implement the COMP is a Permitted Activity under Regulation 38. **The discharge of groundwater from under the reservoir into the natural inland wetland areas on the lower terrace is a Restricted Discretionary Activity under Regulation 39(3A) of the NES-FW.**

Diversion permit for the interception and discharge of groundwater from adjacent to and below the proposed reservoir

Rule LF-TUD-R50 of the One Plan provides for new diversions, including ancillary discharges and disturbances. It is considered that the proposed diversion of groundwater from under the proposed

reservoir is provided for under this rule as a 'new diversion'. The activity is able to meet all of the permitted activity conditions/standards/terms, with the exception of (i) which states that the diversion cannot be undertaken where any infrastructure is located within the river bed 1 km downstream or upstream of the diversion. The new intake structure will be in the bed of the river within this 1km delineation, albeit that this activity forms part of this application. Because the diversion cannot meet the permitted activity standards, it becomes a **Discretionary Activity under Rule LF-TUD-R51**, noting that this Rule does not provide for associated discharges.

Discharge permit for the discharge of groundwater from under the water storage reservoir to water or to land which may result in some overland flow to the Ohau River

The permitted activity rule for discharges to land where the discharge may enter water is Rule LF-LW-R36. The proposed diverted groundwater discharge can meet the permitted activity conditions / standards / terms with the exception of compliance with Rule LF-LW-R35 [compliance with Rule LF-LW-R35 except subclause (a) of that rule is a condition of Rule LF-LW-R36] because the discharge is potentially to a rare habitat (wetland 3) and because it may not be 600mm above the seasonally highest water table; and it is not located at least 20 metres from the nearest surface water body. It therefore falls to be considered as a **discretionary activity under Rule LF-LW-R38**.

Discharge permit for the intermittent discharge of stored water from the reservoir via spillway to the Ohau River if overtopping occurs or if maintenance draw down is required

The permitted activity rule for this activity is Rule LF-LW-R20 and the discharge of stored reservoir water is very likely able to meet all the conditions/standards/terms. For the avoidance of doubt and to ensure long term certainty for the Applicant, consent is however sought under the 'default' **discretionary** rule for discharges of water to water, being **LF-LW-R38.**

Land Use Consent for Riverbed Disturbance to Construct Shallow Bore Intake for Abstraction for Ō2NL Project Construction Water

Rule LF-TUD-R52 provides for the drilling, construction or alteration of any bore pursuant to s9(2) RMA as a Controlled Activity. In this instance, the proposal is to construct the shallow bore (if that is the adopted intake arrangement as per discussion in Section 4.7) within the riverbed of the Ohau River, albeit outside of the active channel area. The construction of the bore is therefore subject to s13 of the RMA and the activity is not provided for under Rule LF-TUD-52.

Water management values of Sites of Significance - Aquatic, and Flood Control and Drainage apply at this location.

Rule LF-AWBD-R54 provides for any excavation, drilling, tunnelling or other disturbance of the bed (including any associated discharge of water or sediment) in reaches of river with a Site of Significance -Aquatic value except for those activities regulated by Rules RP-LF-AWBD-R58 and RP-LF-AWBD-R67 as a Discretionary Activity. Rule RP-LF-AWBD-R58 provides for maintenance and upgrade of structures, and Rule RP-LF-AWBD-R67 provides for activities undertaken by or on behalf of Regional Council in reaches with a Flood Control and Drainage Value. The proposed intake is therefore not regulated under either of these rules, and **consent under Rule-LF-AWBD-R54 as a Discretionary Activity is required.**

Rule LF-AWBD-R68 provides for specified activities in reaches assigned Flood Control and Drainage Value as a Discretionary Activity, where those activities are undertaken, amongst other things, within the bed of the river. The specified bed disturbance activities regulated under Rule LF-AWBD-R68 are:

- any excavation, drilling, tunnelling or other disturbance likely to undermine the functional integrity of a stop bank or river control structure.
- any land disturbance that impedes access required for maintenance of a river or drainage scheme

The construction of the shallow bores, surface intake pipework and any associated infrastructure will not undermine the functional integrity of a stopbank or river control structure, not will they impede access required for maintenance of a river or drainage scheme. The activity is therefore not regulated under Rule LF-AWBD-R68.

8.1 Permitted Activities Included in this Application

The above assessment has identified wetland restoration planting and associated activities as being able to be undertaken as a Permitted Activity.

Further, the taking of water from the reservoir does not require consent, as per the rule guide within section RP-LF of the Regional Plan at page 3-119 which states:

> *"Takes or uses of water from water storage facilities that are not within a water body do not require resource consent"*

'Water body' is defined in the RMA as:

> *"Water body means fresh water or geothermal water in a river, lake, stream, pond, wetland, or aquifer, or any part thereof, that is not located within the coastal marine area".*

It is considered that the reservoir is not a 'water body' under the RMA, and hence the taking of water from it is a permitted activity.

8.2 Overall Activity Status

In accordance with the bundling principle, the activity status for this application is Non-Complying.

9 ASSESSMENT OF ACTUAL AND POTENTIAL EFFECTS OF THE PROPOSED ACTIVITIES ON THE ENVIRONMENT

This section of the AEE assesses the actual and potential effects of the proposal on the environment. In making this assessment it is noted that there are several positive effects associated with this proposal, namely:

- The ability to provide for the health and wellbeing of current and future Levin community via the provision of safe drinking water.
- The ability to improve the resilience of the scheme to climate variations, climate change and natural disasters through the provision of storage, consistent with the direction of the Regional Policy Statement and Regional Climate Risk Assessment.
- The ability to reduce the effect of the abstraction on the River at times of minimum flow, being an effect that is currently authorised by the existing resource consent.
- The proposed restoration and enhancement that will occur on the lower terrace of the reservoir site.

9.1 Cultural Effects

In developing the proposed water storage reservoir and this application, HDC has engaged with Muaūpoko Tribal Authority and with Ngāti Raukawa hapū, namely Ngāti Tukorehe, Ngāti Kikopiri, and Ngāti Hikitanga. The consultation and engagement process is summarised in Section 7. The following sets out the Applicant's understanding of the cultural effects of the proposal as identified through this engagement process.

Muaūpoko Tribal Authority requested that they be engaged to prepare a cultural impact assessment to ensure the values of Muaūpoko are identified and addressed. The CIA prepared by MTA is included in Appendix F.

The CIA findings are summarised (from the Executive Summary of the CIA) as follows:

> *The proposed quantum of water taken from the Ohau Awa, especially at low flow will affect the mauri of the awa, other waterbodies and groundwater that are hydraulically connected to it. The impact on mauri will have adverse effects on Muaūpoko values which must be managed, positive actions must be undertaken to enhance the mauri of the Ohau Awa to offset for the effects the water take will have. The necessity of the project is recognised and Muaūpoko is supportive of a more resilient water supply for Taitoko and the surrounding communities. Our concerns around Horizons Regional Council allocation framework in the Ohau catchment will not be alleviated through this project. However, holding an active role in the continual improvement of the environment will ensure our values, such as mana whakahaere and manaakitanga, can be provided for in a positive way that uplifts our mātauranga and our people. We are looking to create pathways and provide opportunities for decision-making and mahi for our people, whether that be in the planning, construction, kaitiakitanga or kaupapa taiao spaces.*

Tables within the CIA assess the magnitude of the effect of the proposal firstly without management / mitigation and secondly with management / mitigation measures identified by MTA in the CIA. The Applicant has accepted all of the proposed management / mitigation measures proposed by MTA in the CIA and has incorporated these into the proposal and proposed conditions. The effect assessment provided by MTA is summarised as follows (extracted from Section 5 of the CIA). The reader is encouraged to refer to the full text of the CIA in Appendix F for more information on this assessment.

Value	Activity / Effect	Cultural value	Magnitude WITH management	Overall effect
Our worldview				
Growth and knowledge during construction.	Inability to pursue our growth and knowledge as an iwi in the construction phase.	Very high	Positive	Net Gain
Connections with and between our atua during construction	Disrupts the relationships between atua, kaitiaki and the environment in the construction phase.	Very high	Negligible	Low
Growth and knowledge during operation.	The inability to pursue our growth and knowledge as an iwi in the operational phase due to capacity constraints.	Very high	Positive	Net Gain
Connections with and between our atua during operation	Disrupts the relationships between atua, kaitiaki and the environment in the operational phase.	Very high	Low	Moderate
Our whakapapa				
The discovery by our people and their naming in the landscape during construction	Risk of rewriting narratives during construction.	Very high	Positive	Net Gain
The discovery by our people and their naming in the landscape during operation	Severing connections ki uta ki tai during construction.	Very High	Positive	Net gain
Accidental discovery of archaeological materials related to our ancestors during construction.	Disturbing our ancestors' resting places during construction.	High	Negligible	Very Low
Impacts on our terrestrial and aquatic taonga – ngārara and ngata, ika and manu;	The accidental death of our ngārara, ngata, manu or ika and tune associated with Ohau	High	Negligible	Very Low
Te Mana o te Wai				
Mana whakahaere.	Exclusion of our people from decision-making in the project during construction and operational phases.	Very high	Positive	Net gain

Figure 9.1: Summary of Muaūpoko Cultural Effects Assessment
Source: Section 5 of CIA, included in Appendix F.

The above summary shows that the effects of the proposal on Muaūpoko values ranges from positive / net gain to moderate. The CIA concludes:

Offsetting the adverse impact of the project on Muaūpoko values would involve uplifting our position and role as tangata whenua in the Horowhenua and wider landscape as part of the drinking water scheme project. We would be supported to have the capacity and capability to fully participate as a Tiriti partner. This means being empowered to manage our whenua, wai and significant sites in line with our tikanga. In this CIA, we have identified how we wish this to be undertaken, how our values of kaitiakitanga, manaakitanga and mana whakahaere are critical to our success in protecting our interests. We would like to lead the development of a riparian and floodplain restoration plan and its implementation as a way of uplifting Te Mana o te Wai, our rights and responsibilities to manage the Horowhenua Block.

We will continue to work alongside HDC to ensure we deliver the best outcomes for our people, te taiao and the wider Taitoko community in a way that is responsive to our worldview and our whakapapa. Most critically, HDC must respect the way in which we are able to engage because of historic Treaty breaches, exclusion and marginalisation of our people.

We have genuinely applied and held ourselves accountable to the collective vision of the scheme and we will continue to do so.

The CIA includes discussion as to an applicant proposed representative group. This was initially proposed by the applicant as a means of giving effect to Te Mana o te Wai and recognising the respective iwi and hapū across the rohe. In relation to the proposed group, the MTA CIA states that this group "will need to recognise our mana whakahaere and reflect Muaūpoko engagement structure and leadership role as past owners of the whenua for hundreds of years. This is necessary due to past processes of exclusion of our people". To date, a framework and representation for such a group has not yet been able to be agreed between HDC and the iwi and hapū with which it is engaging. Therefore, the proposed conditions do not include a representative group or similar, but do require engagement with each iwi and hapū respectively. Should a representative group be developed in the future, this will provide the same engagement as is required via the proposed conditions.

HDC has, over the last 3 years, engaged with Raukawa hapū and has had several hui with hapū representatives as outlined in Section 7. HDC is currently working with Raukawa hapū as to the specific cultural values or the effects of the proposal on those values. HDC intends to continue to engage with Raukawa iwi and hapū throughout the consenting process to ensure that effects on cultural values are taken into account. HDC also intends that the conditions of consent appropriately provide for the role of iwi and hapū and will further develop such conditions with iwi and hapū through the consent process.

9.2 Construction Effects

9.2.1 Reservoir Intake & Associated Riparian Vegetation Removal

The construction of the reservoir intake and the associated riparian vegetation removal, earthworks and infrastructure construction has the potential to have a significant effect on the river during the construction period. The nature of the proposed activity requires disturbance of the riverbed for construction which has the potential to cause sedimentation at and downstream of the site, introduce contaminants, affect habitat and impact fish passage. As discussed below, with the implementation of the proposed mitigation measures, the effects of construction are considered to be no more than minor.

Appendix I details the proposed construction methodology from the Feasibility Design Report and assesses this against national best practice guidance for undertaking infrastructure construction works in waterbodies. The key guidance document in this regard is the National Works in Waterways Guideline- Best Practice Guide for Civil Infrastructure Works and Maintenance, published by the Ministry for the Environment, July 2021. That document "forms part of the National Works in Waterways toolbox, and sets out the legislative framework, environmental risks, management

objectives and principles, and current best practice" and "provides a framework of best practice to support decision-making and management of activities in and adjacent to waterways."

The best practice measures proposed are detailed in Appendix I, and repeated in Table 9.1 below. Further, an Erosion and Sediment Control Plan which details how sedimentation associated with the in-river and riparian works will be managed is included in Appendix J.

Table 9.1: Best Practice Methods to be Used to Minimise Effects of Construction in Accordance with the National Works in Waterways Guideline Best Practice Guide for Civil Infrastructure Works and Maintenance

Best practice principles for works in waterways	How this principle may be implemented on-site following best practice methodology.
Avoid in-stream works as a first principle	Due to the nature of the proposed activity, in-stream works must occur. Best practice principles will be implemented to reduce the effects of the proposed works. Following best practice, the construction works will be undertaken in the dry to minimise sediment discharges to the river, and in accordance with the Erosion and Sediment Control Plan prepared for this work. This will be carried out by installing a temporary diversion of the active channel within the bed of the river following best practice principles specified in the National Works in Waterways Guideline and regionally specific Erosion and Sediment Control Guidelines for Land Disturbing Activities in the Wellington Region with particular regard for section G4.0. The temporary diversion channel will be constructed as per G4.2.3 of the regional guidance and will minimise sediment generation and discharge from works within the watercourse, following the methodology detailed in the Erosion and Sediment Control Plan. The length of the watercourse to be diverted will be kept to the minimum necessary to enable safe and efficient construction. This also reduces the affected riverbed area which is required for the diversion.
Critically assess the operational methodology	As the works are undertaken, the operational methodology will continue to be critically assessed to ensure that the activity is completed in a way which minimises environmental effects. Qualified and competent contractors will be engaged for the duration of the project and this will be a matter that is taken into account in the procurement process for the contract.
Maintain the streambed profile	The proposed construction works will ensure that any riverbank zones not required for permanent access will be reinstated to their previous contours and revegetated, or rip-rap river protection will be installed. The streambed profile will be maintained after the construction of the intake. Survey will be undertaken prior to the works commencing to confirm the current profile. Once works commence, the existing streambed material will be removed and stockpiled for later use. Following the completion of the works, the stockpiled material will be re-laid generally in accordance with the same bed profile as prior to the works commencing in order to restore the run-riffle-pool sequence of the river bed. Overall, the proposed works will not reduce habitat quality and will not create ongoing erosion issues post-construction.
Retain vegetation on the bank	Vegetation on the bank will be retained wherever possible, and as per the above, riverbank zones not required for permanent access will be revegetated. This includes affected areas as part of the river diversion. Where riparian vegetation must be cleared, disturbance to the river will be minimised by felling vegetation away from the river. Felled vegetation is to be left in-place on the ground for 2-3 days to allow for passive dispersal of terrestrial fauna from the felled vegetation.

Best practice principles for works in waterways	How this principle may be implemented on-site following best practice methodology.
Stabilise exposed areas as soon as possible	The banks will be stabilised to avoid erosion and sediment discharge into water as soon as reasonably practicable. Immediate stabilisation methods such as using geotextile products will be utilised, and follow all relevant protocols and procedures specified in the Erosion and Sediment Control Plan.
Avoid using synthetic materials for in-stream and riparian applications	Biodegradable stabilisation and plant protection options (e.g., entirely biodegradable hessian matting, Combi plant guards) will be utilised for bank stabilisation. This will ensure plastic remnants from synthetic materials cannot enter the environment.
Avoid discharge of sediment into water	The proposed work will be carried out using best practice for works within a watercourse outlined in the National Works in Waterways Guideline and regionally specific Erosion and Sediment Control Guidelines for Land Disturbing Activities in the Wellington Region with particular regard for section G4.0. An Erosion and Sediment Control Plan has been developed as a draft for the purposes of the consent application, and will be updated and finalised prior to construction taking place and provided to the Regional Council for technical certification.
Avoid sediment release downstream	The construction of the stream diversion and required bank works is an area that has the highest potential for sediment release downstream. These works will be carried out using best practice principles and operating under a robust erosion and sediment control plan to avoid sediment release. As part of this, all construction activities will be closely monitored (as detailed in the Erosion and Sediment Control Plan) during construction, before and after every rainfall event, to ensure devices are operating as anticipated, and to ensure sediment release downstream is avoided.
Implement robust erosion and sediment control measures	Appropriate erosion and sediment control measures will be in place to avoid fine sediment entering waterways during works in or adjacent to waterways. An Erosion and Sediment Control Plan has been developed as a draft for the purposes of the consent application, and will be updated and finalised prior to construction taking place and provided to the Regional Council for technical certification.
Avoid discharge of contaminants onto riverbeds or into waterways	A spill response plan will be developed prior to construction works taking place. This will address the potential impacts of the construction of the proposed works, which will ensure the following procedures are in place: • All refuelling of machinery will occur outside of the waterway and in a place where no fuel can enter the waterway if it is spilled. • Ensuring fuels and other chemicals are stored safely away from waterways, and spill kits are available for immediate use for any chemical fuel or other spill. • Store all machinery and equipment above the anticipated flood level at the end of each working day and/or when the site is unattended.
Avoid impediments to free passage	As part of the construction works, fish passage will be maintained or only temporarily disrupted during activities (eg during the creation of the diversion channel and fish relocation processes both prior to and following the construction works). The diversion channel will be constructed to allow for fish passage.

Best practice principles for works in waterways	How this principle may be implemented on-site following best practice methodology.
Avoid disturbance and mortality of freshwater fauna	Due to the proposed works, the excavation of the riverbed will result in some short term disturbance to freshwater fauna. This area will be minimised as far as reasonably practicable. The Wildlands Ecological Assessment for the proposed intake works dated January 2023 notes that once the diversion channel is decommissioned and flow resumes within the main river channel, it is expected that the river will return to its natural form due to the bed movement during flood events. Fish relocation will be undertaken prior to the works commencing with a Fish Management Plan prepared in consultation with iwi / hapū and all necessary approvals obtained prior to commencing. Fish relocation from the temporary diversion channel will also be undertaken prior to the flow being rediverted back into the permanent channel. It is acknowledged that while fish relocation will be carried out, it is not practical or possible to relocate macroinvertebrate species from the construction area. The effects on macroinvertebrate species will be minimised as far as possible by ensuring the disturbed area is kept to the minimum necessary to safely undertake the works. Given the short duration of the construction period, the effects of this disturbance are expected to be similar to a large flood flow which disturbs such species and the resultant time for macroinvertebrate species to re-establish. Any water take pumps which may be necessary (eg for dewatering) will be screened with appropriately 2–3-millimetre mesh to avoid fish mortality due to being drawn into the pumps. The Guideline outlines best practice protocols for fauna relocation and salvage protocols which will be included in a Fish Management Plan prior to construction.
Avoid in-stream works during critical spawning and migration periods	The works will be undertaken at a time to avoid critical spawning and migration periods. The area of the proposed works is not identified as being valued for trout or inanga spawning under the One Plan, nor is it identified as a site of significance - riparian and therefore the exclusion periods specified in Table 15 of the One Plan do not apply.
Avoid the spread of freshwater plant and animal pests	All appropriate biosecurity measures including requirements of the Biosecurity Act and most recent guidance from Ministry of Primary Industries will be followed for any machinery working in the river. In accordance with approved method statements, machinery will be sprayed down and washed prior to river entry in a suitable bunded location, to minimise and avoid the spread of freshwater plant and animal pests, and discharge of contaminants.
Avoid archaeological or wāhi tapu (sacred) sites	The proposed site location does not include any known archaeological or wāhi tapu sites. Conditions of consent and contract will be imposed requiring an accidental discovery protocol to be followed. If any artefacts, taonga or similar are identified, works will cease immediately and the relevant hapū, Regional Council and Heritage New Zealand Pouhere Taonga will be informed.

The construction period for the intake works is expected to take up to two months subject to favourable weather conditions. A key part of minimising disturbance during river works is to minimise the amount of time that the works are undertaken and the bed and natural flow of the river is disturbed. The physical works contract will include, along with all of the consent requirements for these works, a requirement that the contractor confirm all available plant, machinery and equipment is in place to complete the works prior to the works commencing (except for some equipment such as pumps, controls etc which can be installed at a later date as they will be able to be installed once the civil works are completed and without further riverbed or riparian disturbance).

Wildland Consultants Ltd were engaged to undertake an assessment of the effects of the proposed works on the instream and riparian ecology. This is included in Appendix G. This work involved a site visit which was attended by Damwatch as consultants responsible for the preliminary design. The proposed river diversion to enable the construction and construction methodology was discussed in detail at that site visit to inform the ecological assessment.

The ecological assessment recommended a series of standard construction effects management plans including sediment control plan, spill response plan, fish management plan and riparian planting. The Applicant has agreed to implement these recommendations and the content of these Plans is discussed in Appendix I. Further, it is proposed that these management plans be prepared in consultation with iwi/hapū.

A consent condition is offered requiring these plans to be prepared prior to construction commencing. The proposed conditions have been drafted to require an "In-River and Riparian Works Integrated Construction Management Plan" be prepared. This integrated Construction Management Plan (CMP) will include sub-plans for erosion and sediment control, biosecurity risks, spill response, fish management, riparian planting and flood contingency. Often consent conditions are written that require these to be submitted as separate plans. The consent conditions offered by the Applicant propose to have a single integrated CMP for the in-river works. This is expected to avoid duplication of information (eg roles and responsibilities) across multiple plans, require integrated planning and coordination to manage potential effects and make it easier for the contractor, operators, and consent authority to manage implementation and oversight. As a consequence, the integrated CMP is expected to be more effective at managing potential effects than a series of separate management plans.

In terms of the existing riparian vegetation, the ecological assessment found that removal of the riparian vegetation will have minimal ecological effects due to the vegetation being composed of common plant species and extensive amounts of similar habitat being present within the immediate area. This notwithstanding, a riparian planting programme to replace some of the vegetation removed with suitable indigenous species was recommended. The applicant has accepted this recommendation and proposes to undertake such planting upon completion of the civil construction works.

The assessment found that:

> *"While extensive earthworks and a large amount of riverbed excavation will be required to construct the proposed intake structure and its accompanying infrastructure, the ecological effects of this work can be managed effectively through careful planning, particularly in relation to sediment control and the capture and relocation of fish from within the impact reach.*
>
> *Once constructed, the ongoing operation of the intake structure is expected to have minimal ecological effects due to the infiltration gallery being designed to be located below the level of the existing riverbed. Excavation of the riverbed to install the intake structure will result in some short-term disturbance to aquatic fauna in the area and will require extensive recontouring of the riverbed. However, once the diversion channel is decommissioned and flow resumes within the main river channel it is expected that the riverbed will return to its natural form due to bed movement during flood events.*
>
> *Overall, construction and operation of the proposed intake structure will have relatively minor ecological impacts on the Ohau River and its surrounding environment subject to appropriate mitigation measures being implemented."*

9.2.2 Pipe Bridge

The construction of the pipe bridge has the potential to have temporary effects, given that it is to be installed within and nearby to the bed of the river. The scale of these effects is significantly lesser than

those of the construction of the intake structure and these are able to be managed appropriately by way of construction methodology and management plan that follows the best practice principles for works in and near waterways as set out in detail above, and particularly avoiding works in the bed where possible and avoiding any unnecessary discharge of sediment during construction. The proposed consent conditions require an Integrated Catchment Management Plan for this aspect of the project in a similar manner to that described above (noting that the scale of effects to be managed will be significantly less than the intake in-river works).

9.2.3 Reservoir Construction including Associated Infrastructure

The earthworks required to construct the reservoir and its associated infrastructure (access road, spillway, building platforms) are a Controlled Activity under the One Plan, meaning that the effects are already considered to be acceptable and able to be adequately managed through the setting of appropriate consent conditions. The matters of control specified in the One Plan relate to managing the potential for erosion and sediment run-off from the site and subsequent sedimentation of waterbodies, and require that the works be undertaken in accordance with an approved Erosion and Sediment Control Plan (ESCP).

A draft ESCP has been prepared to support this application and is included in Appendix J. As required by the One Plan, it has been developed in accordance with the Erosion and Sediment Control Guide for Land Disturbing Activities in the Wellington Region and taking into account the proposed construction methodology as specified in the Feasibility Report (Appendix B) and approach to construction management as set out in the memo in Appendix I.

The draft ESCP has identified the following key points for the project:

- It is clear that those works associated with the intake structure and Ohau River are of a high risk and need careful and pro-active management and monitoring to ensure that the construction effects are minor.
- A range of ESC measures are proposed on the Project. ESCs will be based on both structural and non-structural measures with an emphasis placed on the non-structural management techniques.
- The Project will rely on specific ESCPs to be submitted to Horizons at a later date, before any construction activity takes place, to allow for contractor input.
- An adaptive monitoring programme will be implemented which will allow for ongoing continuous improvement of the construction water methodologies.

The draft ESCP addresses all of the above matters and concludes that "the effects of the construction aspect of the project, in particular the discharge of sediment, are minor".

The Applicant accepts that a high degree of erosion and sediment control will be required during the construction, and this is standard practice for any construction activity or project of this magnitude and nature. The conditions proposed by the Applicant require the draft ESCP to be updated and finalised prior to construction and for all activities, including any winter earthworks, to be undertaken in accordance with the final ESCP.

In addition to the management of sedimentation, the appointed contractor will be required to prepare and undertake works in accordance with a Construction Management Plan which addresses construction effects such as noise, dust, vibration and traffic management.

Subject to appropriate ESC measures as proposed, and the management of construction effects through an appropriate Construction Management Plan, it is considered that construction effects of the reservoir and associated infrastructure will be no more than minor.

9.3 Hydrology Assessment & Associated Effects

The hydrology assessment considers the effects of the proposed abstraction on the river hydrology and, by extension, on its life supporting capacity. The abstraction scenarios which are required to be assessed are:

- The effect of the core allocation abstraction including the proposed distribution of the core allocation across the intake sites. This assessment is undertaken within the context of the core allocation framework of the One Plan including the determination via the One Plan process that the core allocation volume can be allocated without having significant adverse effects on the life supporting capacity of the river. Further, **it takes into account that the core allocation sought under this consent is already allocated to the Council with the significant majority of that allocation being available until 2042.**
- The effect of the new supplementary allocation sought on the hydrology and life supporting capacity of the river.
- The effect of abstractions at times when the river is at or below minimum flow.

It is noted that the above allocations cannot be easily separated into these three components and therefore an overall assessment is provided to consider the effects of the overall abstraction regime on the river and its life supporting capacity.

The following assessment draws from the hydrology assessment undertaken by Keane Associated Ltd, included in Appendix D.

Horizons Regional Council's technical report[24] to support the One Plan sets out the hydrology and ecological assessment underpinning the establishment of the minimum flow and core allocation framework in general, and for the Ohau River specifically. In Volume 1 of that report, it describes the theoretical framework of establishing minimum flows and core allocation and states that:

> *In this way water is allocated "in a way, or at a rate, which enables people and communities to provide for their social and cultural well being" while the definition of the minimum flow will safeguard "the life-supporting capacity of air, water, soil and ecosystems" as required by the Resource Management Act 1991.*

With respect to the Ohau River, the report references an IFIM (Instream Flow Incremental Methodology)[25] study carried out by NIWA and Horizons on the Ohau River which found that flows of between 700 L/s and 800 L/s provides approximately 80% of optimal habitat for trout rearing and spawning. The minimum flow which has been set in the One Plan is above these estimates (820 L/s). The report also noted that maintaining flow variability is an important consideration in determining the core allocation for the Ohau River and that the number of days between significant freshes was a key factor. It found that allocating more than 280 L/s (as core allocation) from the river would increase the period between freshes to more than 50 days which could affect the ecological balance and water quality of the stream. The core allocation which has been set for the river is 24,192 m^3/day which equates to the 280 L/s quoted.

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[24] *Horizons Regional Council, May 2007, Regional Water Allocation Framework: Technical Report to Support Policy Development - Volume 1.*

[25] *"Instream Flow Incremental Methodology (IFIM) is a habitat assessment method used where the instream management objective is the protection of particular aquatic species, making retention of appropriate habitat a key consideration. It uses models of the hydraulic and morphological characteristics of a stream to determine the amount of habitat available for various species at a range of flows. IFIM is well suited to the physical and ecological characteristics of New Zealand rivers (Ministry for the Environment, 1998).", as per Horizons, May 2007 - Regional Water Allocation Framework: Technical Report to Support Policy Development – Volume 1.*

The core allocation sought is 15,409 m^3/day which is the same as the core allocation already provided to the District Council via its existing consents. **No increase in core allocation is sought.**

What is sought in this application is a redistribution as to where this allocation is to be abstracted within the river, and an extension (by way of the new consent sought) of the timeframe of the existing allocation. The majority of the existing allocation (15,000 m^3/day or 97% of HDC's allocation) is consented through to July 2042. HDC seeks a 35-year consent term in this application, which would essentially extend this allocation timeframe a further 17 years.

In terms of the One Plan policies and rules, there is no distinction as to where, within the overall management area, the core allocation can be taken. However, this is not necessarily the case with the actual effects on the river. Of note, this application seeks to 'move' some of the existing allocation further upstream than the existing point of take which may have an effect given that the abstraction will now be from a smaller watercourse (ie prior to the Makakahi and Makaretu tributaries joining the Ohau River).

Hydrology Assessment Effects Model

The hydrology assessment included in Appendix D details the derivation, for modelling and assessment purposes, of a naturalised flow record for the Ohau River at Rongomatane and understanding of the relationship between the flow in the upper Ohau and Makahika Rivers in order to be able to estimate the naturalised flow regime at the proposed reservoir intake site.

The hydrology effects assessment was then undertaken by modelling the proposed abstraction regime under a worst-case effects scenario. That is, the maximum 15,409 m^3/day is abstracted, with as much of that water taken at the furthest upstream intake (the reservoir intake) as would be provided for in the consent (7,500 m^3/day)[26].

The hydrology water balance model also provided for abstraction of up to 10% of the estimated flow in the Ohau River at the proposed reservoir intake site in order to model the effects of the requested supplementary allocation.

Assessment of Effects of Modelled Abstraction Regime

The hydrology assessment has found that:

- The effect of abstracting up to 7,500 m^3/day of core allocation from the reservoir intake site is a less than 10% reduction in minimum flow, mean flow, upper and lower quartile flows, median flow and FRE3 (FRE3 represents the annual frequency of flushing flow events being flow events greater than three times the median flow).
- The change in FRE3 due to the core allocation abstraction is <1% and the cumulative effect including the supplementary allocation is 7%.
- The confluence with the Makahika Stream is about 800 m downstream from the reservoir intake site and contributes approximately 25% of the natural flow at Rongomatane compared with 45% from the upper Ohau River. The addition of natural flow from the Makahika reduces the effect of abstraction at the reservoir intake on Ohau River flow from this point downstream.
- Downstream from the existing intake, the effect on flow change below median flow is the same as under the current consent. Above median flow, including the effect of the supplementary allocation, the abstraction affect's the flow by up to 8%.

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[26] *Note: For simplicity, these figures have been rounded up in the hydrology assessment. The water balance model has actually modelled a total of 15,500 m^3/day being abstracted, of which 7,500 m^3/day is abstracted at the reservoir intake and the remaining 8,000 m^3/day abstracted at the existing intake. This means that effects will be overstated, albeit by a small margin.*

In terms of the core allocation component, the amount sought is within the overall core allocation of the River and provided for under the One Plan. The key effect for consideration is the impact of shifting some of this allocation upstream such that the abstraction is a greater percentage of the river flow at the point of take. The hydrology assessment has found that the effect of the 7,500 m^3/day core allocation abstraction from the reservoir site is less than 10% change in flow statistics and the scale of these changes is consistent with the flow regime change at the existing intake under the current consent. It is considered that the effects of this abstraction are provided for, and anticipated in, the One Plan allocation framework.

The effect of the core allocation abstraction at the reservoir site is reduced approximately 800 m downstream of the intake with the addition of flows from the Makahika Stream. The stretch of river which is affected is also not subject to the Site of Significance - Aquatic value in the One Plan. The proposal does not seek any abstraction below minimum flow at the reservoir intake site and therefore there is no change to the minimum flow in the river at or downstream of the reservoir intake site.

The effect of the supplementary allocation abstraction, in combination with the core allocation abstraction, results in approximately 7% change in FRE3.

Regional Policy Statement Policy LF-FW-P20 directs the matters that need to be considered in terms of a supplementary allocation. These are:

- The supplementary allocation cannot increase the frequency or duration of minimum flows. The supplementary allocation will only be taken when the river is above median flow and does not have any effect on either the frequency or duration of minimum flows.
- The supplementary allocation cannot lead to a significant departure from the natural flow regime, including the magnitude of the median flow and the frequency of flushing flows. The proposed abstraction does not lead to a significant departure from the natural flow regime as evidenced in the hydrology assessment and summarised in Figure 9.2 below. That shows the combined effect of the reservoir intake abstraction (which is the only location where supplementary allocation is to be taken) on the Ohau River at the point of the abstraction. This has been derived from applying the abstraction to the derived naturalised flow regime at the point of abstraction. It shows that, below the median flow the abstraction (being the core allocation component) does not cause significant change in the natural flow regime. Between the median and 25th percentile, the abstraction affects the natural flow regime by 10% in accordance with the supplementary allocation policy. Above the 25th percentile, the amount of water abstracted as a percentage of the natural flow reduces (as it is not possible with the proposed pump capacity to abstract the full 10% of the supplementary allocation).

  In terms of flushing flows, the FRE3 (being 3 times the median flow) is normally used to assess flushing flows. The proposed abstraction influences the flushing flow at the intake site by less than 5% and does not impact on its frequency.
- The supplementary allocation shall not cause any adverse effects that are more than minor on the RP-SCHED2 values of the water body or its bed. The effect of the abstraction on RP-SCHED2 values is assessed in Section 9.7 below and is found to be no more than minor.
- The supplementary allocation shall not limit the ability of anyone to take water under a core allocation. The supplementary allocation regime is separate from the core allocation regime and the proposed abstraction does not impact on any other person's ability to take water under the core allocation regime.
- The supplementary allocation shall not derogate from water allocation to hydroelectricity generation. There is no such water use on the Ohau River and therefore the supplementary allocation does not impact on water allocation to hydroelectricity generation.

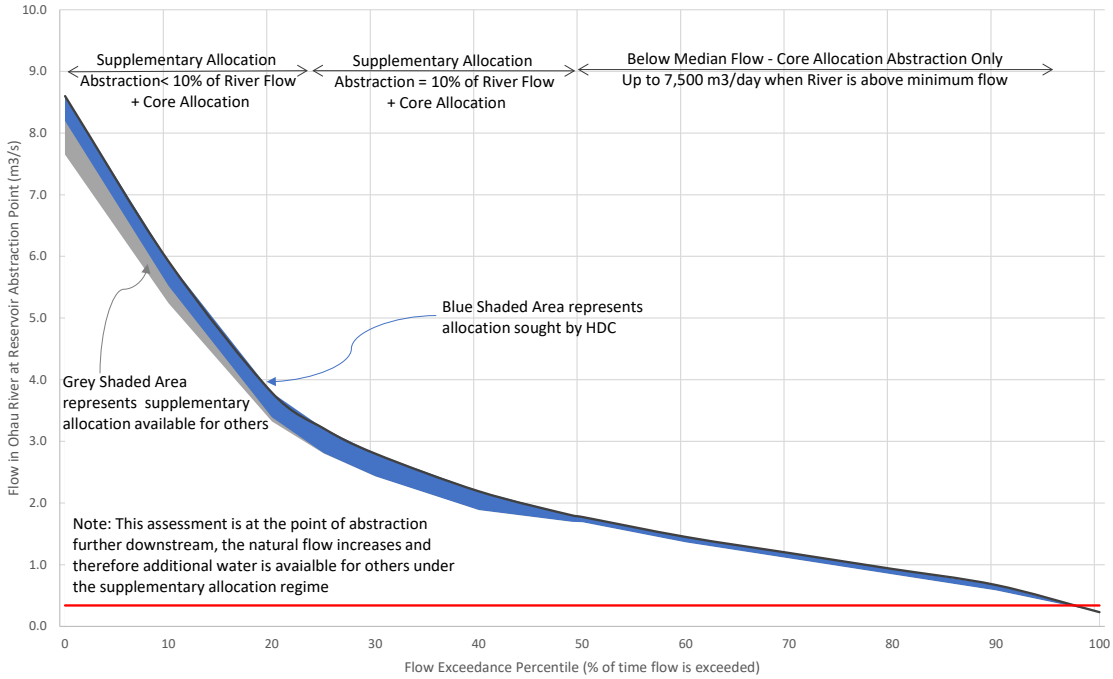


Figure 9.2: Effect of Reservoir Abstraction (supplementary allocation) on Naturalised Flow Regime of the Ohau River at the Reservoir Intake Site

The above demonstrates that, in terms of the effects determined relevant in the Regional Policy Statement for grant of supplementary allocation, the effects of the proposed abstraction are less than minor.

9.3.1 Effects of the Abstraction Below Minimum Flow

The effects of the proposal will be a reduction from the existing consented effects of the abstraction below minimum flow. As described throughout this AEE, the Council is currently authorised to abstract up to 13,000 m^3/day when the river is below minimum flow. The only criteria that needs to be satisfied for Council to exercise this abstraction is for the trigger level 4 water restrictions to be imposed. With the current infrastructure and lack of bulk storage, Council must abstract from the river at all times when it is below minimum flow in order to maintain supply to the community. This will continue – as is provided for under the current consent – until the reservoir is built and operational.

The reservoir, including the ability to fill the reservoir by way of the supplementary allocation sought, enables the Council to avoid abstraction from the river below minimum flow in all but exceptional circumstances or extended drought. Further, it enables the Council to significantly reduce the amount of water abstracted below minimum flow in such circumstances.

For the flow record available, the maximum number of days per year that the river has been below minimum flow is 50 days. This occurred in the 2003/2004 summer. This summer period also had the maximum number of consecutive days below minimum flow, being 25 days. A statistical analysis[27] also found that 26 consecutive days below minimum flow would be considered a 100-year return period event.

Rather than abstract consistently at 13,000 m^3/day in this event as is currently required, the proposed reservoir enables supply to be maintained during such periods via a mixture of supply from the reservoir and supply from the river. The analysis in section 4.1 shows that this could be met by a

[27] *As reported in section 2.5.1 of the Options Report, Appendix A.*

mixture of days with no abstraction from the river and a mixture of days with a combined river-reservoir supply. The amount of water which would need to be abstracted from the reservoir is highly dependent on the reservoir levels leading into the drought period, community demand and the extent to which there are freshes during the summer period to enable the reservoir to be refilled.

The overarching principle will be to avoid or minimise abstractions from the river below minimum flow as far as possible, to minimise effects on the river and to give effect to the first priority objective of Te Mana o te Wai. Section 4.1 has proposed a series of criteria that are required to be met in order to exercise the abstraction below minimum flow. These criteria reduce the potential for the minimum flow abstraction to be exercised unnecessarily following the construction of the reservoir.

It is acknowledged that abstractions below minimum flow in exceptional circumstances or extended drought will have an effect on the river. This effect will, after the reservoir has been built, be extremely infrequent (eg only required in drought periods of 50 – 100 year return periods or less frequent) and will be less than the effect which is authorised via the current consent. The proposal to reduce and avoid such abstractions as far as possible and to provide a consent condition framework that requires engagement with iwi/hapū and post-event reviews and improvements to be undertaken is considered appropriate to minimise these effects as far as practicable whilst also providing for the second-tier priority of Te Mana o te Wai being the needs of people.

9.3.2 Effects of Climate Change on Hydrology and Projected Abstraction Effects

To ensure the robustness of the proposed water harvesting scheme, the effects of climate change on the flow regime in the river have been assessed. HDC, via its design consultants, engaged Williamson Water & Land Advisory to develop a catchment model to assess the impacts of nine climate change scenarios on the flow regime of the Ohau River catchment upstream of Rongomatane (refer Appendix E).

That assessment found that by 2030 – 2050, climate change effects are predicted to have little impact on key flow statistics. By 2081 – 2100, climate change effects are predicted to result in a small reduction in low flow statistics for the higher order RCP climate scenarios.

In the medium term, flow in the Ohau River is most likely to be controlled by the weather patterns experienced and not gradual climate change. Risks associated with drought are expected to be similar risks to the existing situation through until about 2050 (this has been assessed as "high" risk in the regional risk assessment discussed in Section 5.1). After 2050, risks associated with drought are considered to increase to extreme by 2100 on a regional scale.

Therefore, within the term of consent sought, there is not expected to be a significant change in the Ohau River flow regime on which the allocation framework and effects assessment has been based. The proposal is consistent with the recommended approach in the Regional Climate Change Risk Assessment for managing risks to water supply in the short to long term, being the addition and enhancement of storage, combined with an improved water demand management approach, in order to enhance the adaptive capacity of the water supply system.

It is therefore considered that the effects of climate change do not materially affect the assessment of effects included in this application and the proposal is consistent with the recommended regional approach for managing drought risks associated with climate change in the longer term.

9.3.3 Effects of Water Take and Associated Intakes for Provision of Construction Water for Ōtaki to North Levin State Highway 1 Project

The proposal includes enabling the abstraction of some of the allocation provided to HDC under this consent to be abstracted immediately upstream and downstream of the SH1 bridge in order to provide construction water for the Ōtaki to North Levin (Ō2NL Project) State Highway 1 project. It is

considered that this use is consistent with the general purpose of the use of water to support the community's social and economic wellbeing as it will enable the construction of a key infrastructure project in the district.

As discussed in Section 4.1.3, HDC recognises that it will have compliance responsibility for any such take. It proposes to enter into a formal agreement with NZTA for the use of this allocation, with that agreement being founded on the principle of Te Mana o te Wai. A high degree of communication between HDC and NZTA will be implemented with the amount of water which NZTA may be able to use varying on a day-to-day basis during peak periods to ensure compliance. NZTA proposes to abstract water into stormwater ponds which, for the purpose of the Ō2NL Project's construction period, are being re-purposed as water storage ponds. This means that abstraction not being available will not impede the Ō2NL Project's construction programme and also means that abstraction from the awa can be at average demand levels and does not need to meet peak demand for construction water.

As detailed in NZTA's Ō2NL Project consent application:

> *A strategy has been adopted for the abstraction of water to support construction of the Project that will minimise the overall construction water requirements, re-use water collected through construction, utilise existing sources (for example, boreholes), only take water from the existing Core Allocation of a catchment (unless water in streams and rivers is above median levels), only abstract water above minimum flow, and make extensive use of water storage to meet demand during any extended period of low flow. Water will be abstracted from a combination of sources to minimise any potential effect on the environment.*

This strategy will apply to any water used by NZTA under the consent sought by way of this application.

The proposed abstraction from the Ō2NL intake site is within the core allocation limit as prescribed in the One Plan. The One Plan allocation framework does not consider where within a water management area the allocation is abstracted. The proposal will mean that some of the allocation will be taken at a point further downstream than the current Levin water supply intake during the Ō2NL Project's construction period. By abstracting water further downstream where the river has received inflows from other tributaries, the effects will be no more than what is currently authorised at the WTP intake site.

The use of the water for this purpose is considered to be an example of efficient allocation of water as it enables some of the Council's existing allocation to be used for a short period of time for a specific infrastructure project that will support the social and economic wellbeing of the community in a way which avoids over-allocation of the river. If this water were not able to be made available for this use, the Ō2NL Project would need to source construction water from other water courses across the Ō2NL Project reach. This would increase the risk that there is insufficient water for construction purposes, requiring a slowing down of the construction of the Ō2NL Project, or resulting in significant cost increases as water will need to be sourced from watercourses further afield, and also generating additional greenhouse gas emissions costs of the project.

The proposed intake arrangements have been discussed in Section 4.7. If the surface intake option is adopted, no riverbed disturbance will be required and therefore there will be no bed disturbance effects. The intake screen will have a mesh aperture size not exceeding 3mm in diameter and an intake velocity of less than 0.3 m/s, consistent with the permitted activity criteria of Rule LF-TUD-R39. These screening details will ensure that fish and aquatic organisms are not entrained or captured. The use of the storage ponds also enables the water abstraction to be kept to average, rather than peak, rates therefore reducing the rate of take and impacts of the abstraction on the flow velocities in the immediate vicinity of the intake.

If the shallow bore intake option is adopted, some riverbed disturbance to construct the bores will be required and consent is sought for this activity. The riverbed disturbance is during the construction of the bores itself (i.e. not ongoing throughout the period of abstraction) and this is likely to be able to

be undertaken within a few days. The shallow bores will be located outside of the active channel and there is no requirement for any disturbance or machinery within the flowing water channel. Any disturbance from this construction is less than would be expected when a small fresh occurs (ie any short duration flood event that submerges the lower parts of the river channel).

The River in this area is assigned a value of Sites of Significance - Riparian for the purposes of protecting gravel and sand habitat for dotterels and mud/silt habitat and estuarine roosts for waders. The relevant habitat to be protected at this site is gravel and sand habitat, and there is potential that there may be nesting dotterels in the area. It is therefore proposed that a bird survey be conducted no earlier than 3 days prior to the bores being constructed and that the bore construction only proceed if that bird survey does not identify any active dotterel nests within 50m of the proposed work.

Overall, given the allocation sought at this intake is within the allocation framework authorised in the One Plan; that it provides for efficient allocation of water; and that bed disturbance activities are limited to a very small timeframe, scale and outside of the active channel, it is considered that the effects of this aspect of the proposal are no more than minor.

9.4 Water Quality Effects

In addition to the construction effects discussed above, the proposed activities have the potential to affect the water quality of the Ohau River through the routine maintenance of the infiltration gallery (in particular the activation of the air backwash system), and through the discharges from the groundwater drainage underneath the reservoir and from the reservoir spillway.

9.4.1 Effects of Infiltration Gallery Air Backwash System

This system has been discussed in Section 4.2 and will include intermittent backwash of an air / water mix (water sourced directly from the river via the infiltration gallery abstraction) through the gabion basket array beneath the river bed in order to remove silts or sediment build up in the gallery.

The ecological assessment in Appendix G assessed this activity and noted that this activity could potentially release sediment into the Ohau River and cause localised disturbance of the resident fish population during periods when it is in operation. However, the assessment found that:

> *"Operation of the air backwash system for routine maintenance is unlikely to have anything other than a minor effect on the aquatic environment. Any disturbance to aquatic fauna will be temporary, and the discharge of sediment is likely to be similar to that which occurs during natural events."*

A key principle underpinning the air backwash system is the ability to undertake more frequent, but less disturbing backwash cleaning of the intake gallery. The current intake at the water treatment plant requires significant, but less frequent bed disturbance which requires machinery to be used in the riverbed to undertake scarification and other activities (authorised under a resource consent specifically for this activity). In comparison, the air backwash system at the reservoir intake site will enable a much more frequent backwash operation so that there is not significant build-up of sediment in between backwashes. This means that there is less sediment to be dislodged when backwashing occurs. Further, the River in this location has a generally better water quality than at the existing WTP intake site given that it is upstream of, and on a separate tributary to, the slips in the catchment which are a large source of sediment in the river water. This means that there is less sediment to become entrained in the intake gallery that will require backwash. Operational practice during the commissioning period will determine how frequently the backwash system will need to operate.

Overall, and for the reasons set out above, it is considered that the effects of the backwash system will be no more than minor.

9.4.2 Effects of Groundwater Diversion and Discharge

The proposed reservoir includes a groundwater diversion and discharge system which will collect groundwater from below the reservoir and discharge it to ground on the river terrace. This system is critical for the integrity of the reservoir liner as it avoids groundwater pressure building up below the reservoir if groundwater levels were to naturally be above the base of the reservoir.

Discharge volumes from the groundwater system will vary depending on natural groundwater levels and seasonal variations. It is estimated that the discharge volumes will be in the order of 14-42 m^3/day. This will be discharged to ground on the river terrace in a way which will seep into the ground and / or may flow overland to reach the Ohau River. The quality of this discharge will be groundwater with no contaminants introduced.

At its maximum anticipated discharge rate of 42 m^3/day, the discharge - if it were to all reach the Ohau River - represents only 0.06% of the minimum flow for the River (820 L/s). Given the extremely low contribution of the discharge to the river flow; that this scenario of maximum groundwater discharge coinciding with minimum river flow is highly unlikely to occur but is a worst case estimate; and that the discharge is clean groundwater with no contaminants, it is considered that any effects from the discharge of groundwater will be less than minor.

The above has considered the effects of the discharge to the extent that it may enter the River flows. This is a conservative assessment of the effects of the discharge on the River. The discharge will not enter the River via a direct point source discharge. It is proposed to utilise the diverted groundwater in the proposed cultural effects offsetting works and wetland restoration to be carried out on the lower terrace. At present, some of the groundwater that will be diverted is likely to be appearing as surface water on the lower terrace via seeps and springs at the base of the terrace and contributing to the water in the wetland 2 site (refer Figure 3.12). The diverted groundwater will be directed to feed into the wetland restoration areas of sites 3-5 identified on the lower terrace to ensure an appropriate hydrological environment for the wetlands. The quality of water discharged will be the same as the groundwater that is currently entering these areas. It is therefore considered that the adverse effects of the diversion and discharge will be no more than minor.

During construction, sediment controls will be put in place to avoid sediment discharges as set out in the Erosion and Sediment Control Plan and discussed in section 4.3 above to ensure that the effects of any construction discharges are no more than minor.

With regard to the matters set out in Regulation 56 of the NES-FW to which discretion is restricted in relation to the assessment of the discharge of diverted groundwater to the wetland restoration areas at sites 3-5, it is considered that the key matter is (g), being the "social, economic, environmental and cultural benefits (if any) that are likely to result from the proposed activity (including the extent to which the activity may protect, maintain or enhance ecosystems)."

The purpose of this aspect of the proposal is to help ensure that there is an overall environmental and cultural benefit as a result of the project. The purpose of the discharge to the wetland areas is to increase their values and improve the hydrological regime. With the exception of the risk of sedimentation during construction, which has been addressed at length elsewhere, the discharge does not require particular offsetting or other management measures given its purpose and will result in a net benefit for those wetland areas.

9.4.3 Effects of Spillway Discharge

The spillway discharge will occur only under vary rare circumstances. The primary mechanism for a spillway discharge is when the reservoir is at its fullest level and there is heavy rainfall at the reservoir site. This may cause the reservoir level to rise above its maximum operating level and flows to be

discharged via the spillway. This is a design feature required to prevent overtopping of the embankments and subsequent potential failure of the reservoir.

In this event, it will be a mixture of stored reservoir water (being water previously abstracted from the Ohau River) and rainwater being discharged back to the Ohau River. The quality of the discharge water and the receiving environment is therefore considered to be the same. Given this scenario is initiated by heavy rainfall, the river is also expected to be well above its minimum flow levels and therefore less vulnerable to any discharge effects. The effects of the spillway discharge in this event are considered to be less than minor.

The other scenario for spillway discharge is a failure of the abstraction control system which results in the abstraction pumps continuing to operate when the reservoir level is full. In this case, the discharge would essentially be the return of water to the river immediately after its abstraction. The effects of this discharge are considered de minimus as it is return of river water to the river without any temporal delay. Any such discharge would also be temporary as the control system will include a series of back up alarms to advise the operator of the malfunction and, failing that, would be detected upon routine operational visits.

The final discharge scenario is in the event that the reservoir needs to be drawdown quickly for operational reasons. Routine operations and maintenance activities would not require this to be activated as the maintenance would be programmed at times when the reservoir level was low and /or the reservoir levels would be manipulated to be drawn down by preferential use of stored water to supply the community, and reduction in river abstraction. However, there may be times when the reservoir level would need to be dropped via discharge to the river, for example for inspection purposes following an earthquake to check on the structural integrity of the reservoir or to undertake repairs or to ensure adequate turn-over within the reservoir. In this event the discharge would be of stored water of similar quality to the River. The discharge rate would be limited by pump capacity to pump from the reservoir into the spillway and any such pump rate would not be sufficient to cause downstream flooding or similar effects.

The effects of the spillway discharge, under all of the scenarios where such a discharge may occur, are considered to be less than minor.

9.5 Ecological Effects

The potential ecological effects of the proposed activities that need to be considered include the potential disturbance and loss of habitat during the construction phase of the new intake; and the potential effects on the life supporting capacity and habitat for freshwater species arising from the water abstraction; and effects on natural inland wetlands.

9.5.1 Reservoir Intake

In terms of the construction phase, the potential effects include loss of habitat due to the riparian vegetation clearance, earthworks and intake infrastructure as well as disturbance and realignment of the riverbed to construct the infiltration gallery. These construction effects have been separately assessed in section 9.2 above. The ecological assessment (Appendix G) found that the riparian vegetation in this area was composed of tutu, toetoe and exotic pampas grass, with the understorey being a mixture of indigenous species including coprosma, mahoe and wheki. It states that “no rare or threatened indigenous vegetation was observed during the site visit, with all indigenous species being widespread and common”. The vegetation and habitat that will be disturbed therefore is not considered a rare, threatened or at-risk habitat in terms of RP-SCHED6 of the One Plan. It is noted that RP-SCHED6 states that any riparian margin not classified elsewhere in RP-SCHED6 as a rare or threatened habitat which is within 20 m landwards from a river with RP-SCHED2 value of Site of Significance – Aquatic must be considered to be at-risk whether it is indigenous or exotic. In this instance, the area where vegetation disturbance will occur is not a stretch of the river which has

RP-SCHED2 value of Site of Significance – Aquatic and therefore the riparian habitat is not considered "at risk". The ecological assessment states that the removal of riparian vegetation "will have minimal ecological effects". This notwithstanding, it also recommended a riparian planting programme to replace some of the vegetation removed with suitable indigenous species. This recommendation has been accepted by the Applicant and a condition is proposed to require the recommended riparian planting programme be developed and implemented thereby ensuring no net loss of riparian habitat quality. The effect of the proposed works on the riparian habitat and its ecological value is therefore considered to be less than minor.

The impact of the construction phase on the in-river habitat and fish species has also been assessed in section 9.2. This includes a series of mitigation measures including diversion of the flowing channel within the river bed to enable the works to be undertaken in the dry and prevent downstream sedimentation of the water and also to prevent effects on in-stream species from construction machinery in the active channel. It is noted that there will be some unavoidable effects of this diversion on macroinvertebrate species that are within the channel when it is diverted. These effects are limited to a length of the river of approximately 300 m. Given the small stretch of river affected and the short duration of the construction period, the effects of this disturbance are expected to be similar to a large flood flow which disturbs such species and the resultant time for macroinvertebrate species to re-establish.

A Fish Management Plan will be prepared to capture and relocate fish within the affected area prior to the works being undertaken, as well as from the temporary diversion channel prior to flow being reinstated to the permanent channel after completion of works. Further, the methodology involves temporary removal and stockpiling of the riverbed material and then reinstatement of the same at the same grade as the existing river bed after completion. This will ensure that the riverbed strata and the riffle, run, pool environment is maintained post construction. Following construction, the riverbed habitat will be the same as prior to construction. The effects of the intake construction on the in-river habitat and fish species are therefore considered to be less than minor.

9.5.2 Water Abstraction

The effects of the water abstraction, including on the life supporting capacity of the river, have been assessed in Section 9.3. The proposed abstraction regime is entirely within the allocation framework provided within the One Plan. The development of that allocation framework by Horizons Regional Council was informed by IFIM studies (Instream Flow Incremental Methodology) which found that between 700 and 800 L/s needed to be maintained in the Ohau River to provide for 80% of optimal habitat for most species. The minimum flow for the river has been set at 820 L/s (ie above the flow required to maintain 80% optimal trout habitat) and the proposal is not to abstract below minimum flow except in exceptional circumstances as described above. It therefore follows that the effects of the abstraction on trout rearing and spawning are within that anticipated in the setting of the allocation framework within the Regional Plan and are less than minor. Refer also to the discussion in Section 9.3.

9.5.3 Natural Inland Wetlands

The proposed reservoir will result in the loss of a small area of approximately 400 m^2 which has been assessed as having a "marginal classification" as a natural inland wetland. This is Site 2 in the Wildlands ecological assessment report in Appendix H and Figure 3.12 above. This wetland has been assessed by Wildlands as "highly modified" and with vegetation that is "predominantly exotic, and .. not ecologically significant". Wildlands have assessed Site 2 has having "little potential for ecological restoration".

The NES-FW requires that the Effects Management Hierarchy be applied to consideration of effects on natural inland wetlands. The Effects Management Hierarchy is defined in the NPSFM as follows:

***effects management hierarchy**, in relation to natural inland wetlands and rivers, means an approach to managing the adverse effects of an activity on the extent or values of a wetland or river (including cumulative effects and loss of potential value) that requires that:*

(a) adverse effects are avoided where practicable; then

(b) where adverse effects cannot be avoided, they are minimised where practicable; then

(c) where adverse effects cannot be minimised, they are remedied where practicable; then

(d) where more than minor residual adverse effects cannot be avoided, minimised, or remedied, aquatic offsetting is provided where possible; then

(e) if aquatic offsetting of more than minor residual adverse effects is not possible, aquatic compensation is provided; then if

(f) aquatic compensation is not appropriate, the activity itself is avoided

The adverse effects on Site 2 are not avoidable given the functional need to construct the proposed reservoir in a way which requires drainage and construction over the wetland (refer Appendix H). Nor can the effects on Site 2 be minimised given that the site is entirely within the reservoir footprint and that it has been assessed as being of "limited ecological value" (ie, it is difficult to minimise effects on values which are already considered to be of limited value). It is also not possible to remedy the effects of the proposed reservoir, as that would require mitigation to be carried out in the same location as Site 2. Application of the effects management hierarchy therefore requires aquatic offsetting to be provided. The ecological assessment report has identified that the loss of Site 2 "can be offset by the restoration of the degraded wetlands on the lower terrace".

Wildlands has identified that, while sites 3 to 5 on the lower terrace will not be directly affected, there is potential - although unlikely - for indirect effects due to sedimentation inputs during construction activity on the upper terrace are possible due to changes in surface and subsurface flows. The ecological assessment has identified that these effects can be avoided by implementing the following:

- Appropriate controls on sediment management during construction phase
- Maintaining the opportunity for surface flow from the upper terrace to travel to the lower terrace.

These avoidance methods will be implemented by the Applicant. All of the proposed earthworks will be undertaken in accordance with an Erosion and Sediment Control Plan consistent with the relevant guidelines, and a draft has been included in this application. Following construction there will still be conveyance of surface flows (albeit from a small catchment area given the reservoir will capture rainfall within the reservoir) to the lower terrace, as well as additional flows from the groundwater beneath the reservoir. Adverse effects on sites 3 to 5 will therefore be avoided, as required by the first tier of the Effects Management Hierarchy.

Wildlands have recommended ecological restoration of the lower terrace as this "would easily outweigh the adverse effects of very minor 'losses' on the upper terrace". An Ecological Restoration Plan has been recommended to guide this and should include:

- Definition of the area subject to the plan
- Stock exclusion
- Wetland planting
- Wetland riparian planting
- Terrestrial planting
- River riparian planting
- Monitoring and maintenance of plantings

- Pest animal monitoring and control
- Restoration / planting targets
- Reporting

The Cultural Offsetting Management Plan (Appendix L) which has been prepared to address cultural effects of the abstraction involves significant restoration of the lower terrace. The draft COMP includes all of the above elements and is considered to meet the purpose and content details of the recommended Ecological Restoration Plan. The Applicant has proposed conditions required the draft COMP to be finalised prior to implementation and that this include review by a suitably qualified ecologist to confirm that there will be no net loss of wetland extent or values.

Wildlands have therefore concluded that:

> *Restoration of the wetland areas on the lower floodplain of the Ohau River would easily mitigate the loss of Site 2, and this approach would very substantially outweigh the minor adverse effects associated with the loss or modification of this small, highly modified 'marginal' wetland.*

Therefore, it is considered that the effects of the proposal on natural inland wetlands will be positive as it will result in a net gain in wetland extent and values. Further, it will bring the restoration area into a consent condition framework that requires ongoing monitoring and maintenance of the restoration area to maintain the net gain in extent and values throughout the consent duration.

9.6 Flood Hazards

There are two aspects to flood hazards which need to be considered. Firstly, the impact of the proposed activities on the flood carrying capacity of the Ohau River in general and the Ohau Flood Control and Drainage Scheme in particular. Secondly, potential effects arising from the extremely unlikely event of a failure of the reservoir structure and subsequent quick release of the stored water into the Ohau River.

9.6.1 Effects on Flood Control and Drainage Scheme

In terms of flood carrying capacity of the river, the abstraction element of the proposal obviously does not have an adverse effect on flood carrying capacity.

The proposed reservoir intake is a sub-surface intake and there will be no structures within the riverbed after construction. Therefore, after construction it has no effect on the River's flood carrying capacity. During construction, the main channel will be diverted to a temporary channel within the river corridor which will be designed to ensure it has sufficient capacity to manage expected diverted flows. However, if a large flood event occurs during the construction period, it is expected that this will be conveyed via the diversion channel and the area where construction is occurring. Construction does not require significant material and equipment to be located within the riverbed works area while the site is being actively worked on. A Flood Contingency Plan will be developed as part of the integrated construction management plan and will include provisions for monitoring long term weather forecasts and for exiting the construction area and removal of all machinery in the event of anticipated or forecast flood flows. This will include making use of the Horizons Regional Council River Alert System and regular communications with the Horizons River Management Team. The Flood Contingency Plan will ensure that materials which may be in the riverbed which could pose a potential downstream risk will be removed from the riverbed prior to the flood event. The construction period for the in-river works is relatively short (approximately 2 months) and therefore these measures will be able to be easily implemented and reflect standard best practice construction methodology.

The proposed pipe bridge presents a potential constraint in terms of flood carrying capacity. However, the effect of this is considered less than minor as the proposed bridge will not result in any structures within the flood channel (ie no piers or structures in the river) and will be at the same height as the

existing road bridge. It therefore does not present any constraint or change the existing flood carrying capacity of the river.

The Ohau River is valued for Flood Control and Drainage Values in respect of the Ohau Manakau Scheme under the One Plan. This value applies from approximately 250 m downstream of the proposed reservoir intake site to the coastal marine area. In preparing this application, HDC has engaged with Horizons Regional Council's Area Engineer responsible for this scheme who advised verbally that they do not consider that the proposal will impact on the scheme and that there are no flood protection assets in the vicinity of the proposed works. They further advised that the Flood Control and Drainage Value has been applied in the upper Ohau in order to be able to undertake catchment improvement measures that may contribute to flood protection. The proposed activities do not impact on the ability to undertake such measures and do not impact on the Flood Control and Drainage Value.

9.6.2 Potential Effects in Event of Reservoir Embankment Breach

The proposed reservoir, when full, will hold 740,000 – 855,000 m^3, the larger volume being at the embankment crest level and therefore assumes that the freeboard height in the reservoir is fill. Such a scenario cannot occur, given the spillway level to allow for controlled overflows back into the river has a level set at lower than the embankment crest height and the spillway discharge at this level occurs via gravity and does not rely on operator intervention. Nonetheless, to assess the worst-case effects scenario, the total reservoir volume of 855,000 m^3 has been used in the analysis of effects of a potential reservoir embankment breach. This assessment is described in Section 3 and Appendix B of the Feasibility Design Report in Appendix B.

The reservoir is considered a large dam under New Zealand's Dam Safety Guidelines (NZDSG) and a dam break assessment is required to be undertaken in accordance with the procedures set out in those guidelines and under the Building (Dam Safety) Regulations 2022. Part of this process is a Potential Impact Classification, or PIC, which assesses the potential embankment failure mechanisms, assumes a worst case (ie dam full) breach occurs and assesses the potential impact of that breach. It includes modelling the area that would be inundated in this event and assesses the likely number of persons, property and significant sites affected. This then informs the level of design, construction and ongoing monitoring required to prevent such a breach scenario occurring. That is, the dam breach analysis is not one which is used to assess likely effects that may or may not be acceptable but is used to inform the design requirements to avoid adverse effects occurring.

Given the proposed reservoir is off-river and not affected by potential flood flows, and because of the proposed reservoir spillway, an embankment breach due to overtopping is not a credible failure mechanism and therefore has not been assessed. The only credible failure mechanisms for the reservoir (refer Table 20 of the Feasibility Design Report) are a liner failure resulting in concentrated seepage through the embankment; or a seismic event which would also cause a concentrated seepage through the embankment. Identifying the credible failure mechanisms informs the design and monitoring requirements to avoid such failures.

In terms of infrastructure at risk, the embankment breach scenario represents a flow generally equivalent to the 1:100 year flood at the reservoir site and dissipates (ie reduces) as it progresses further downstream. Assuming the existing Poads Road bridge over the Ohau River is capable of conveying the 100 year flood flow, this will not be affected by a breach of the reservoir. By the time the breach flows have reached the State Highway 1 bridge, the peak has reduced to be less than the mean annual flood and does not present a risk to the State Highway or other infrastructure. As above, this is a theoretical breach event, and the assessment informs the design and monitoring required to prevent such a breach occurring.

Based on the assessed population at risk in a breach scenario of 15 persons, the reservoir has been assessed as Potential Impact Classification of "Medium". It is noted that even if the assumptions made

in the assessment raised the population at risk significantly to any number up to 100, it would still be assessed as a Medium Potential Impact Classification under the Dam Safety Guidelines. Therefore, the reservoir will be designed, monitored and maintained to meet the design standard for a medium PIC dam.

A PIC assessment has been undertaken in accordance with the Building (Dam Safety) Regulations 2022. This assessment considers the hypothetical event of dam failure and does not take into account the likelihood of that failure. However, modern water retaining structures, such as the Poads Road Water Storage Reservoir, have an extremely low likelihood of failure. As such, the likelihood of Potential Loss of Life from dam failure is also considered extremely low. This high level of dam safety is achieved by specification of appropriate performance criteria used in the design and construction of a dam (regulated by the Building Code 2004) and by close monitoring and management throughout the operational life of a dam by means of a comprehensive Dam Safety Management System, as regulated by the Building (Dam Safety) Regulations 2022 for Medium and High PIC structures.

9.7 Effects on RP-SCHED2 Values

The One Plan RP-SCHED2 values for which the Ohau River is to be managed have been identified in Section 3.2.1. The values which have potential to be affected by the proposed activity have been assessed in detail above. For completeness, the following assesses the effects of the proposed activity on all of the RP-SCHED2 values relevant to this application and as identified in Section 3.2.1. RP-SCHED2 Values identified in Section 3.2.1 as not relevant to the proposed activity are not discussed.

- Life supporting capacity: As discussed above, the proposed activity will not affect the life supporting capacity of the river. The effects of the construction activities have been determined to be less than minor and the proposed abstraction is within the allocation framework determined as appropriate for supporting the life supporting capacity of the river during the development of the One Plan. The proposal will also significantly reduce the need for the Council to abstract when the river is at or below minimum flow.
- Aesthetics: The activities will not change the aesthetics of the river. The in-river works will be undertaken in the dry and will be undertaken in accordance with management plans and a construction methodology which is consistent with national best practice guidelines for such works. There are no discharges other than occasional discharges of water of the same quality as the source water and no chemicals or other contaminants will be discharged.
- Contact Recreation: The activities do not affect the ability for contact recreation activities to be undertaken and enjoyed. The abstraction is provided for within the allocation framework and will not affect the availability of water for contact recreation and the activities will not discharge any contaminants which may affect people's enjoyment of the river or its riparian areas for contact recreation purposes.
- Mauri: the applicant has engaged with iwi/hapū to understand the cultural values and impacts of the proposed activities, and a Cultural Offset Management Plan has been prepared to address effects of the abstraction on the mauri and habitat of the Ohau. The COMP requires offsetting to ensure that there is no net loss of mauri or habitat as a result of the proposed activities.
- Industrial Abstraction: There are no known industrial abstractions from the Ohau River. The proposed abstraction is sought within the allocation framework provided for in the One Plan and does not adversely affect the rights or abilities of any other users.
- Irrigation: There are some abstractions in the lower Ohau which are used for food production including likely irrigation activities. The proposed abstraction is within the allocation framework and does not prevent any other users from exercising any existing water permits. As discussed in Section 9.3, supplementary allocation above that sought by the Applicant, but within the One Plan allocation framework remains available for other users.

- Stockwater: As with other consumptive uses described above, the proposed abstraction does not affect any other users' ability to exercise existing legal rights to abstract water for this use.
- Existing Infrastructure: The proposal is enabled by consideration of this value, as it provides for the ongoing use and improved resilience of the Levin Water supply infrastructure. The assessment in Section 9.6 has also demonstrated that the proposal does not impact on the existing flood carrying capacity of the river and therefore does not impact on the roading or other infrastructure in, or near, the river corridor.
- Site of Significance – Aquatic. This value does not apply at the proposed reservoir intake site. As discussed in Section 9.3, the proposed abstraction does not adversely affect the hydrological or instream conditions and habitat and the effects on significant aquatic species are considered less than minor.
- Trout Fishery – Other. The allocation sought is within the allocation framework which includes establishment of a minimum flow to protect habitat for trout and other species. The effects of the proposal on trout fishery are therefore considered less than minor.
- Trout Spawning. The allocation sought is within the allocation framework which includes establishment of a minimum flow to protect habitat for trout spawning. The effects of the proposal on trout spawning are therefore considered less than minor.
- Water Supply. The proposed activities are consistent with and enabled by this value. The proposed activities enable a significant improvement to the management of the Levin Water supply which is the only water supply which is provided for via the application of this value to the Ohau River.
- Domestic Food Supply. There are some abstractions in the lower Ohau which are used for food production. The proposed abstraction is within the allocation framework and does not prevent any other users from exercising any existing water permits. As discussed in Section 9.3, supplementary allocation above that sought by the Applicant, but within the One Plan allocation framework remains available for other users. The proposal does not include the discharge of any contaminants and therefore it does not affect the quality of water within the Ohau river for this use.
- Flood Control and Drainage. As assessed in section 9.6, the proposal does not affect any of the Flood Control and Drainage assets on the Ohau River nor does it impact on the flood carrying capacity of the River.

The proposal therefore provides for, and does not adversely affect, any of the values identified in the One Plan for which the Ohau River and its tributaries are to be managed. The effects of the proposal on these values are considered to be less than minor.

10 PROPOSED CONDITIONS OF CONSENT

Throughout this AEE several measures have been identified as consent conditions proposed by the Applicant in order to ensure that there are appropriate controls and oversight of the proposed activities and that measures offered to manage environmental effects are adhered to throughout the implementation of the project and the term of consent. These have been developed into a suite of proposed consent conditions which are included in Appendix M.

The following diagrams summarise the proposed consent conditions.

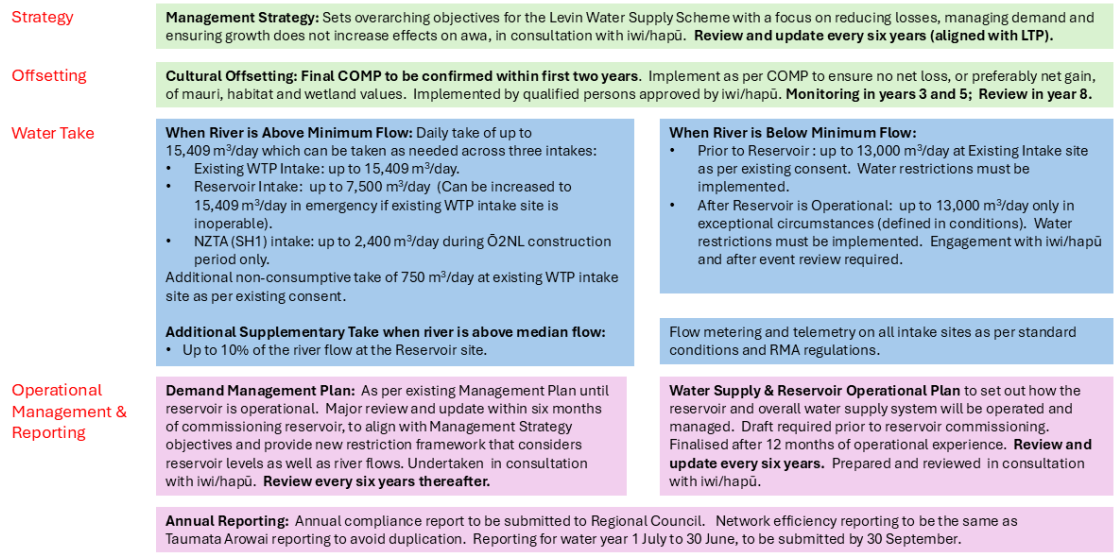


Figure 10.1: Proposed Consent Conditions for Operation of the Scheme

It is proposed to prepare a "Management Strategy for the Levin Drinking Water Scheme" (Management Strategy) which will provide the over-arching guidance and direction for the operation of the Levin water supply scheme. The proposed consent condition requires that the Council, as consent holder, adopt the following Management Objectives for the scheme and requires the Management Strategy to detail how these will be achieved during the term of the consent:

- The amount of treated drinking water lost to leakage from the Levin water supply system will be reduced.
- Existing and new households will be supported to invest in and construct rainwater tanks.
- Beneficial uses for treated wastewater will be identified, investigated and where proven feasible adopted to minimise freshwater takes.
- Sustainable outcomes for resource management including minimising energy use must be achieved.
- Freshwater takes during low flow will be minimised through ongoing review and implementation of best management practice.
- The effects of the drinking water take will not grow over time in response to urban growth as a result of the Management Strategy.

The proposed condition requires the consent holder consult with iwi and hapū during the preparation of the Management Strategy and that the Management Strategy be updated no less frequently than every six years. This will allow the update of the Management Strategy to be aligned with alternate Long Term Plan (LTP) cycles enabling any funding implications from the review and update of the Management Strategy to be provided for in the Council's LTP budget.

The proposed consent conditions require operational plans for the system (ie the Demand Management Plan and Water Supply and Reservoir Operational Plan) to give effect to the Management Strategy. Similarly, their review is required no less frequently than every six years, again enabling alignment with alternative LTP cycles so that any funding implications arising from the review can be provided for in the Council's LTP budget.

The preparation and review of the Management Strategy and operational plans is required to be undertaken in consultation with iwi and hapū.

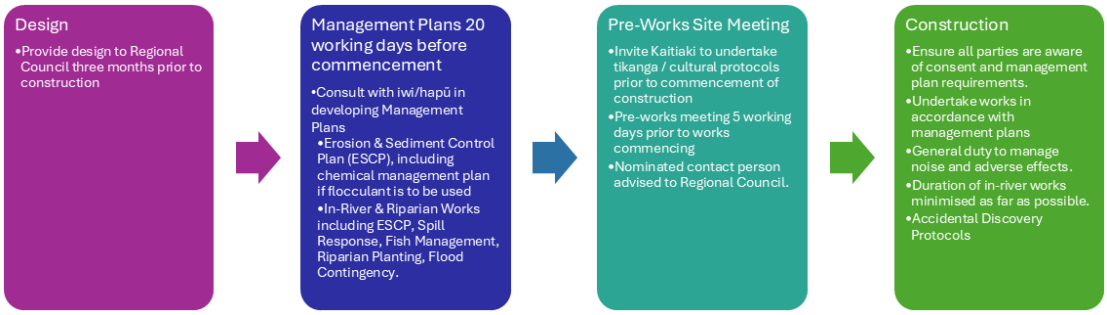


Figure 10.2: Summary of Construction Conditions

The construction conditions offered are summarised in Figure 10.2 above. These are standard construction conditions for projects of this nature and scale and require construction management plans, including erosion and sediment control, spill response fish management, riparian planting and flood contingency management plans to be prepared and provided to Regional Council prior to commencement of works. The proposed conditions require that these be developed in consultation with iwi/hapū and that iwi/hapū be invited to undertake tikanga and cultural protocols prior to commencement of works.

The use of Construction Management Plans (CMP) facilitates innovative and adaptive construction methods to be utilised and provides for flexibility in response to matters encountered during construction while ensuring that potential environmental effects are appropriately managed. As discussed above, a single integrated CMP is proposed for the in-river works. This is expected to avoid duplication of information (eg roles and responsibilities) across multiple plans, require integrated planning and coordination to manage potential effects and make it easier for the contractor, operators, and consent authority to manage implementation and oversight. As a consequence, the integrated CMP is expected to be more effective at managing potential effects than a series of separate management plans.

11 RMA AFFECTED PARTIES AND CONSULTATION

This section details the consultation and engagement which has been undertaken with parties considered to be potentially affected by the proposed activities in terms of section 95 of the RMA. It must be noted that the decision to proceed with this project, the way in which the Levin Water supply is managed and operated, and the funding decision to implement the project is subject to the Local Government Act consultative procedures and are outside of the scope of this application.

Muaūpoko Tribal Authority (MTA)

Council has engaged actively with in the development of this proposal, as has been described earlier.

The Applicant recognises that the engagement and consultation undertaken with MTA as discussed in an earlier section does not necessarily preclude MTA from being considered as a section 95 RMA affected party and that, in accordance with both natural justice as part of the principle of self-determination, it is for MTA to decide if it considers itself to be so affected. HDC will continue to actively engage with MTA via the consenting, design, construction and operational phases of the project.

Te Runanga o Raukawa & hapū - Ngāti Tūkorehe, Ngāti Kikopiri, Ngāti Hikitanga

Council has actively engaged with Raukawa iwi and hapū in the development of this proposal, as has been described earlier.

The Applicant recognises that the engagement and consultation undertaken with Raukawa iwi and hapū as discussed in an earlier section does not necessarily preclude these parties from being considered as affected in terms of section 95 RMA and that, in accordance with both natural justice as part of the principle of self-determination, it is for Raukawa iwi and hapū to decide if it they consider themselves to be so affected. HDC will continue to actively engage with Raukawa iwi and hapū via the consenting, design, construction and operational phases of the project.

Landowner of Intake Site Works

While the reservoir and new pipeline will be constructed on land owned by the applicant, HDC and / or road reserve under HDC's control as Road Controlling Authority, the new reservoir intake and associated infrastructure is located on the adjacent landowner's property. This property, being Lot 1 DP 12594, extends across the river bed and the intake is required to be constructed on this property. There is little scope to move the intake location as any further upstream the bed substrate becomes bedrock and an infiltration gallery option is not possible, and any further downstream (ie further downstream such that the intake could be located on land owned by HDC) the alluvial terrace is lower than the indicative flood level and siting the intake downstream would mean that associated structures such as sumps and backwash air pumps would be at risk during flooding.

HDC is currently engaging with this landowner with respect to an easement/property rights over this area and associated mitigation.

Department of Conservation

Detail of the proposal have been provided to the Department of Conservation along with an offer to meet to discuss the project and / or undertake a site visit in the early stages of the project development (2022). The Department of Conservation has advised that they have received the information and will be in contact with any feedback (January 2023). To date, no feedback has been received.

Fish and Game Council

Details of the proposal have been provided to the Wellington Fish and Game Council in the early stages of the project, along with a copy of the draft ecological assessment report, and HDC's consultant planner has met with the Fish and Game Council's Resource Officer to provide background information and discuss the project.

Horizons Regional Council – Rivers Management Team

Details of the proposal have been provided to the Horizons Regional Council – Rivers Management Team and HDC's consultant planner has met with the Area Engineer responsible for the Ohau-Manakau River and Drainage Scheme. The Area Engineer advised that there were no scheme assets which would be affected by the proposal and agreed that the proposed pipe bridge (being a single span at the same height as the existing road bridge) would not affect the flood carrying capacity of the river.

New Zealand Transport Agency Waka Kotahi (NZTA)

The applicant has actively engaged with NZTA in the preparation of this application as far as it relates to the use of water to support the construction of the Ōtaki to North Levin (Ō2NL) road. This engagement has been to ensure that there is efficient use and allocation of water by enabling the council to seek appropriate consents to secure the medium to long term supply for the community whilst also ensuring that allocated water is able to be used efficiently in the short term via use for the construction of the Ō2NL Project, being infrastructure of regional or national importance under Policy EIT-P1 of the One Plan.

Neighbouring Properties

The properties directly adjacent to the sites of works that are not owned by the Applicant, include Lot 3 DP 555714 which is adjacent to the pipe bridge site on the downstream side. This property was sold via a subdivision process undertaken by HDC in 2021, and is subject to a no objection clause (by way of a covenant on the title) regarding HDC establishing a water storage facility on the adjacent land. The pipe bridge is an associated activity and is one that is permitted by the network utility provisions of the District Plan. Any effects on the adjacent property associated with the pipe bridge will be temporary in nature and construction related and it is considered that any such effects will be minor or less than minor.

The site adjacent to the property on which the intake structure will be located is Lot 1 DP 63053. Again, the effects of the intake structure on this property will be temporary and construction related and are considered to be minor or less than minor.

12 POLICY AND PLANNING ASSESSMENT

Section 5 of this AEE presented a summary of the statutory and policy drivers that have been determinative in establishing the need for the reservoir and this application, and in shaping how the overall proposal has been developed. In summary:

- The Applicant has obligations under the Water Services Act and the Local Government Act to provide safe drinking water supply of sufficient quantity to its community, and to do so in a way which gives effect to Te Mana o te Wai.
- The Levin water supply has been identified as one which has high to extreme climate change risks, as determined by the Regional Council's Regional Climate Change Risk Assessment. That Risk Assessment further identifies that responding to this risk will require the "enhancement of storage and ability to manage water demand levels - particularly in areas such as … Levin where development and growth is occurring." The proposal is consistent with this recommended response to climate change risks to water supply.
- The Levin water supply is required to be recognised as regionally significant infrastructure under the Regional Policy Statement, which also requires that infrastructure be provided in a coordinated, integrated and efficient manner to provide for sufficient development capacity for housing and business uses.
- The community's water demand has been assessed as being reasonable and justifiable in accordance with the provisions of the Regional Policy Statement and the projected growth demands (which are based on the same per-capita demand as existing) are therefore also considered to be reasonable and justifiable. Further, the Council has invested, and continues to invest, significant expenditure in addressing leakage throughout the network and installing universal metering to enable effective and efficient demand management.
- The National Policy Statement on Urban Development requires that sufficient development capacity to meet expected demand for housing and for business land over the short, medium and long term. It also specifies that "sufficient development capacity" requires the land to be infrastructure ready. The significant increase in growth that has occurred since the current Levin water supply consent was granted, and the projected growth that has been zoned and is yet to occur, requires that the Council ensure that it has sufficient capacity within its water supply system to meet these growth demands. This is not the case with the current consent, and the water harvesting and storage proposal enables sufficient capacity to be met whilst also giving effect to Te Mana o te Wai by avoiding and reducing the effects of the abstraction at minimum flow.

The following sets out a detailed assessment of the proposal against the matters specified in Section 104 and Part 2 of the RMA.

12.1 Section 104 Matters

Section 104 of the RMA sets out the matters which the consent authority must have regard to, subject to Part 2 and Section 77 of the Act, when considering an application for resource consent. An assessment against Part of the RMA is provided in Section 12.2 below. Section 77M of the Act relating to Medium Density Residential Standards is not relevant to the proposed activities.

The following sections provide consideration of the relevant matters set out in section 104 RMA, to assist in the consideration and determination of the Application.

Section 104(1)(a) Any actual and potential effects on the environment of allowing the activity

The actual and potential effects of the proposed activities are addressed in detail in section 9 of this Application. All actual and potential adverse effects are assessed as being minor or less than minor, but not more than minor. The project also provides for positive effects in terms of providing for urban development and growth while improving resilience of the scheme; reducing the need for abstraction below minimum flow thereby reducing the effects of the current consented abstraction on the river; and enabling cultural offsetting and habitat and wetland restoration.

Section 104(1)(ab) Any measure proposed or agreed by the applicant for the purpose of ensuring positive effects on the environment to offset or compensate for any adverse effects on the environment that will or may result from allowing the activity

The Applicant acknowledges that the proposed taking of water from the Ohau River will have an effect on the River in the sense that it does not enable the River to be retained in its natural state, albeit that takes of the volumes proposed are already consented (ie the River is already not in its natural state). Additionally, the proposed intake structure will have an effect on the bed of the River, especially during construction and likewise the Reservoir will have an effect on the existing environment in the sense that it is large scale infrastructure being introduced into an environment where this does not currently exist.

However, as set out in section 9 of this Application, it is considered that the proposed operational framework for the water take and the scope of the proposed physical works have been set out in such a way so as to avoid more than minor adverse environmental effects and that effects that do arise will be remedied or mitigated to the extent possible such that they are minor or, less than minor. Further, the overall effects of the project will be significantly beneficial in terms of reducing existing effects on the Ohau River and providing resilience improvements for the water supply network.

Irrespective that the effects of the proposal will either be positive, minor or less than minor, the Applicant recognises that effects of the abstraction on the mauri of the awa and ground disturbance to construct the reservoir have been identified as a concern by iwi and has therefore agreed to undertake offsetting activities to not only address these effects but, provide a positive outcome.

The Cultural Offsetting Management Plan (COMP) has been developed in order to guide and direct the offsetting activities. The proposed conditions require the COMP to be developed and implemented on a timeframe that is independent from the reservoir construction and thereby ensure that there is no delay in undertaking offsetting activities. The proposed COMP has also been assessed as providing offsetting that will more than outweigh the effects of the reservoir construction on the natural inland wetland (of marginal classification) currently within the proposed reservoir footprint.

It is considered that COMP will assist in ensuring overall positive effects on the environment as a result of the proposed new large scale infrastructure.

Section 104(1)(b)(i) Any Relevant Provisions of a National Environmental Standard

There are three National Environmental Standards (NES) that are potentially relevant to this application.

National Environmental Standard for Sources of Drinking Water 2007 **(NES Drinking Water)**

The NES Drinking water sets requirements for protecting sources of human drinking water from becoming contaminated. Although, the activities will occur upstream and in close proximity to a drinking water source, they are not barred by regulations 7, 8, 10 or 12 of the NES Drinking Water because the activities will not breach the health quality criteria and guideline values set out in the NES Drinking Water. There are no other drinking water supply takes downstream of the proposed activities that trigger the regulations of the NES Drinking Water.

It is noted that the Applicant is the same entity as the Water Services Provider for the Levin water supply. The Levin water supply is the only registered drinking water supply sourcing water from the Ohau River which services no fewer than 501 people for not less than 60 days each calendar year. Regulations 7, 8, and 10 only apply to activities which may affect registered drinking water supplies meeting this population threshold. Further there are no registered drinking water supplies sourcing water from the Ohau River that service no fewer than 25 persons, and therefore regulation 12 also does not apply.

National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health 2011 (NESCS)

The NESCS provides a nationally consistent set of planning controls and soil values to ensure that land that has been affected by contaminants is appropriately identified and assessed before land disturbance and/or development occurs and, if necessary, remediate, or the contaminants contained to make the land safe for human use. The NESCS applies if an activity or industry described in the Hazardous Activities and Industries List ("HAIL") is undertaken, has been undertaken, or more likely than not, is being or has been undertaken on the land. The areas where the intake is proposed, the reservoir, and the pipe bridge are not included in the HAIL and there is no indication that these areas are contaminated making it very unlikely that the NESCS is relevant to the construction (land use) aspects of the proposal. However, if any evidence of contamination were to be discovered as part of the detailed design and preparatory works for the construction of the Reservoir, consent from the District Council could and would be sought under the NESCS at that time.

National Environmental Standard for Freshwater 2020 **(NES Freshwater)**

The proposal includes activities that require consent under the NES Freshwater in relation to wetlands. The regulations that are relevant have been identified in Section 8 of this AEE and the matters requiring consideration have been assessed in detail in Section 9.4.2 and 9.5.3 and are summarised and discussed as follows.

Natural Inland Wetland within Reservoir Footprint
In summary, there is an area within the reservoir footprint that has been assessed as a Natural Inland Wetland of marginal classification. Taking a precautionary approach, it has been assumed that this area does meet the Natural Inland Wetland definition of the NES Freshwater and consent is required to undertake earthworks within and within 100 m of the wetland, and to drain the wetland.

The reservoir is 'specified infrastructure' as it meets the NPSFM definition of specified infrastructure which includes "any water storage infrastructure". There is therefore a consenting pathway for the works affecting the Natural Inland Wetland as a Discretionary Activity under Regulation 45 of the NES Freshwater. For consent to be granted under Regulation 45, the consent authority must:

a. Be satisfied that the specified infrastructure will provide significant national or regional benefits. In this case, the proposal is for infrastructure which is recognised as nationally or regionally significant in the Regional Policy Statement; provides for projected community growth; improves the resilience of the water supply system; and addresses a high-extreme climate change risk identified in the Regional Climate Change Risk Assessment. It therefore provides significant regional, if not national, benefits.

b. Be satisfied that there is a functional need for the specified infrastructure in that location. A functional need assessment (Appendix K) has found that there is a functional need for the reservoir to be in the proposed location as it is the only site which has sufficient land; access to a suitable intake site on the Ohau River where there is sufficient and good quality source water; and has suitable and sufficient area to enable mauri and habitat enhancement to offset cultural effects of the abstraction. In addition, it was found that a smaller reservoir on the site (such that the Natural Inland Wetland would not be impacted), would not provide sufficient storage to avoid the need to abstract from the Ohau River below minimum flow.

c. Apply the Effects Management Hierarchy. The effects management hierarchy has been applied and discussed in detail in section 9.5.3. This has found that the effects on the Natural Inland Wetland are not avoidable or able to be minimised given the functional need to construct the reservoir in that location. Nor can they be remedied at the same location as the existing wetland. The ecological assessment has confirmed that the effects "can be offset by the restoration of the degraded wetlands on the lower terrace" as is proposed through the Cultural Offsetting Management Plan. It has also found that ecological restoration of the lower terrace "would easily outweigh the adverse effects of very minor 'losses' on the upper terrace." The ecological assessment also found that any potential adverse effects on the wetlands on the lower terrace can be avoided. Therefore, the effects management hierarchy has been applied.

The tests of Regulation 45(a) to (c) have been met and consent is therefore able to be granted as a Discretionary Activity for the works impacting the Natural Inland Wetland.

Natural Inland Wetlands on Lower Terrace (Restoration / Enhancement Area)
Consent is also sought for the discharge of groundwater from under the reservoir into the natural inland wetland areas on the lower terrace. This has been assessed as a Restricted Discretionary under Regulation 39(3A) of the NES Freshwater. The matters to which discretion has been restricted are specified in Regulation 56 of the NES Freshwater. These are assessed as follows:

a. *The extent to which the nature, scale, timing, intensity and location of the activity may have adverse effects on the existing and potential values and extent of the natural inland wetland; the seasonal and annual hydrological regime and the passage of fish in the natural inland wetland.*
The proposed works will have an overall positive effect on the natural inland wetlands of the lower terrace and will result in an increase in values and extent. The ecological assessment has found that any adverse effects can be avoided by implementation of appropriate controls on sediment management and maintaining the opportunity for flows from the upper terrace to travel to the lower terrace, as proposed in the application.

b. *Whether there are practicable alternatives to undertaking the activity.*
As discussed above, and in the Functional Need memo in Appendix K, there are no practicable alternatives to undertaking the proposed activity.

c. *The extent to which those adverse effects will be managed to avoid the loss of extent to the natural inland wetland and its values*.
As stated above, the ecological assessment has found that any adverse effects can be avoided by implementation of appropriate controls on sediment management and maintaining the opportunity for flows from the upper terrace to travel to the lower terrace, as proposed in the application. The proposed restoration / enhancement will more than likely result in an increase in the wetland extent and values and conditions are proposed to ensure no net loss on wetland extent or values.

d. *Other measures to minimise or remedy those adverse effects.*
Other measures are not necessary as any potential adverse effects are able to be avoided.

e. *how any of those adverse effects that are more than minor may be offset or compensated for if they cannot be avoided, minimised, or remedied.*
Ther are no adverse effects that are more than minor, and therefore there is no requirement for offsetting or compensation.

the extent to which the effects of the activity will be managed through applying the effects management hierarchy:
Any potential effects are able to be avoided, in accordance with the first priority under the effects management hierarchy.

f. *the risk of flooding upstream or downstream of the natural inland wetland, and the measures to avoid, minimise, or remedy that risk.*
The natural inland wetlands are located on a floodplain terrace which is expected to receive floodwaters during larger events as part of the natural hydrological regime. The proposal does not affect, in any way, the flooding risks or frequency that naturally occurs.

g. *the social, economic, environmental, and cultural benefits (if any) that are likely to result from the proposed activity (including the extent to which the activity may protect, maintain, or enhance ecosystems).*
The overall project has positive social and economic effects as it enables the provision of safe and sufficient water supply to the community for current and future needs. It has environmental benefits in that it will avoid, in all but exceptional circumstances, the need to abstract from the river below minimum flow, and implementation of the Cultural Offsetting Management Plan will ensure that there is no net loss, and likely a net gain, in terms of mauri and habitat values.

The assessment against the matters of discretion listed in Regulation 56 demonstrates that any effects of the proposed activity as it relates to the natural inland wetlands on the lower terrace will be less than minor, if not positive, and that there are no matters which would preclude grant of consent.

There are no other consenting requirements under the NES Freshwater, noting that one of the reasons that a subsurface intake was chosen for the proposal was to avoid on-going effects on fish passage. There are potential temporary impacts on fish passage during construction, which will be managed via a diversion channel and fish relocation as described in detail previously.

Section 104(1)(b)(ii) Any Relevant Provisions of Other Regulations

The Resource Management (Measurement and Reporting of Water Takes) Regulations 2010 are relevant to the proposed water take given that the proposal is for fresh water to be taken at a rate of more than 5 litres/second. Section 4.1.3 has discussed how the applicant proposes to meter and report on the amount of water taken at each intake and across the system. The Applicant would expect that the standard conditions relating to measurements, records and reporting would be imposed on any grant of consent, with the requirement for metering, records and reporting to apply at each of the intake sites such that the proposal would comply with the Water Take regulations.

There are no other regulations that are relevant to the assessment and determination of the Application.

Section 104(1)(b)(iii) Any Relevant Provisions of a National Policy Statement

National Policy Statement for Freshwater Management 2023

The NPSFM supports improved freshwater management in New Zealand and establishes Te Mana o te Wai as a fundamental concept relevant to all freshwater management. It directs regional councils to establish objectives and set limits for freshwater in their regional plans.

The NPSFM requirement to give effect to Te Mana o te Wai is a key driver for the project, as set out in detail in section 5 of this Application. It is considered that the proposal clearly gives effect to the Te Mana o te Wai by avoiding and reducing effects on the river as far as possible while also providing for the wellbeing of the Levin community.

The proposal is considered to be consistent with the policies of the NPSFM as set out below.

Table 12.1: NPSFM23 Policy Assessment

NPSFM23 Policy	Assessment
Policy 1: Freshwater is managed in a way that gives effect to Te Mana o te Wai	Refer section 5 of this application, and the analysis provided in Table 5.1. The proposal will reduce the environmental effects of the drinking water supply on the Ohau River by enabling the Council to avoid, in all but exceptional circumstances, the abstraction of water from the Ohau River during times of minimum flow.
Policy 2: Tangata whenua are actively involved in freshwater management (including decision making processes), and Māori freshwater values are identified and provided for.	This policy is being met by way of on-going engagement with iwi / hapū and treaty partners in relation to the project and the development of this application. Further, the Applicant proposes a suite of consent conditions which require the ongoing consultation, engagement and involvement of iwi / hapū through the development of the Management Strategy for the scheme; operational management plans for the reservoir and network demand management and through active involvement in the management of construction effects.
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 policy is met through the robust options assessment included in this application, the integration of the proposal with land use planning initiatives and strategies and the hydrology and effects assessments included herein.
Policy 4: Freshwater is managed as part of New Zealand's integrated response to climate change.	One of the key drivers for the project is to increase resilience to climate change, as set out in section 5.
Policy 5: Freshwater is managed (including through a National Objectives Framework) to ensure that the health and well-being of degraded water bodies and freshwater ecosystems is improved, and the health and well-being of all other water bodies and freshwater ecosystems is maintained and (if communities choose) improved.	The health and well being of the Ohau River is maintained if not improved, through the proposed activities for example, by enabling the Council to avoid, in all but exceptional circumstances, the abstraction of water from the Ohau River during times of minimum flow.
Policy 6: There is no further loss of extent of natural inland wetlands, their values are protected, and their restoration is promoted.	There will be no overall loss of natural inland wetlands as a result of the proposed activities rather, there will be a net gain in wetland biodiversity values. A small area which may be classified (albeit marginally) as a natural inland wetland and which has been assessed as being of low ecological value will be lost as a result of the proposal. However, the Applicant has agreed to the proposed cultural and wetland offsetting and restoration activities which will deliver a net gain of natural inland wetland extent and values substantially outweighing the loss of this area.

NPSFM23 Policy	Assessment
Policy 7: The loss of river extent and values is avoided to the extent practicable.	It is considered that there will be no loss of river extent and values as a result of the proposed activities.
Policy 8: The significant values of outstanding water bodies are protected.	Whilst the Ohau River is not an 'outstanding water body' in terms of the Regional Plan, its significance to iwi / hapū and communities in the area is recognised. It is considered that the intrinsic values of the River will continue to be able to be expressed and that its significance will not be compromised by the proposed activities.
Policy 9: The habitats of indigenous freshwater species are protected.	Adverse effects on freshwater habitats are able to be avoided through use of a subsurface intake rather than an alternative arrangement; construction effects are able to be appropriately mitigated including, replacement of removed vegetation with indigenous species; and the proposed water take is within the core allocation framework for the water body, other than in exceptional circumstances. It is considered that the habitats of indigenous freshwater species are able to be protected in carrying out the proposed activities, in accordance with this policy. Implementation of the proposed COMP will ensure not net loss, and preferably a net gain, with respect to mauri and habitat values.
Policy 10: The habitat of trout and salmon is protected, insofar as this is consistent with Policy 9.	Effects of the proposed activities on these habitats will be less than minor and the application is consistent with this policy.
Policy 11: Freshwater is allocated and used efficiently, all existing over-allocation is phased out, and future over-allocation is avoided.	As set out in detail within this Application, the Regional water management framework has been a key driver for this application, and particularly the core allocation and supplementary allocation provisions. The proposal does not include an activity that would constitute over allocation and is considered to be an efficient use of water and therefore consistency with this policy is achieved.
Policy 12: The national target (as set out in Appendix 3) for water quality improvement is achieved.	The proposed discharges will have less than minor effects that will not affect the national target for water quality improvement. Likewise, the proposed takes will not contribute to an inability to achieve this target.
Policy 13: The condition of water bodies and freshwater ecosystems is systematically monitored over time, and action is taken where freshwater is degraded, and to reverse deteriorating trends.	This proposal is not of specific relevance to the proposed activities. This notwithstanding, implementation of the COMP introduces a framework for monitoring the cultural health of the awa in this area.
Policy 14: Information (including monitoring data) about the state of water bodies and freshwater ecosystems, and the challenges to their health and well-being, is regularly reported on and published.	This proposal is not of specific relevance to the proposed activities.
Policy 15: Communities are enabled to provide for their social, economic, and cultural wellbeing in a way that is consistent with this National Policy Statement.	It is considered that the proposal contributes to the ability for this policy to be carried out by allowing individuals and businesses to access fresh drinking water.

National Policy Statement for Urban Development 2020 **(NPSUD20)**

The NPSUD20 is relevant as a key policy driver in terms of the need to be able to supply Levin and surrounds with additional water, as discussed within section 5 of this Application. As explained above, the NPSUD obliges the Applicant to provide sufficient development capacity to meet expected demand for housing and business land and requires the Applicant to be satisfied that the additional infrastructure to service the development capacity is likely to be available. The growth rate that has occurred since the existing consent was granted, and the projected growth rates over the term of consent sought - including through the development of housing areas which have recently been zoned via the Taraika plan change - are such that the current consent does not provide sufficient water for the housing and business land needs to be met. The proposal will enable the council to implement a water harvesting and storage regime that will provide sufficient water to meet projected growth needs and enable council to fulfil its obligation to provide infrastructure ready land for housing and business development.

The consents sought by way of this application are a critical component to the Applicant being able to meet its obligations under the NPSUD so that it can provide municipal water supply to support well-planned growth in Levin.

There are no specific considerations in terms of the proposed physical works under this NPS.

National Policy Statement for Highly Productive Land 2022 **(NPS Highly Productive Land)**

The NPS Highly Productive Land seeks to protect highly productive land for use in land based primary production. This NPS is not of specific relevance to the proposal because the proposed activities are not located on land that is classified as 'highly productive' for the purpose of this NPS. The Regional Council has not yet mapped highly productive land in its Regional Policy Statement. Clause 3.5(7) of the NPS Highly Productive Land states that until maps of highly productive land are operative in a regional policy statement, highly productive land (for the purpose of the NPS) is defined as land that:

- is zoned general rural or rural production land AND is Land Use Capability (LUC) class 1, 2 or 3; but
- is not land identified for future urban development or subject to a Council initiated or an adopted, notified plan change to rezone it from general rural or rural production to urban or rural lifestyle.

The site is zoned rural and is not identified for future urban development or subject to a plan change. The LUC Class for the reservoir site is LUC 4 and the lower floodplain terrace is LUC6. As the site is not LUC Class 1, 2, or 3 it is not Highly Productive Land and the NPS Highly Productive Land does not apply.

Section 104(1)(b)(iv) Any Relevant Provisions of the New Zealand Coastal Policy Statement

The NZCPS is not relevant to the consideration of this Application.

Section 104(1)(b)(v) Any Relevant Provisions of a Regional Policy Statement or Proposed Regional Policy Statement

The Regional Policy Statement of the One Plan (RPS) includes a significant number of issues, objectives and policies that are relevant to this application. The most relevant aspects of the RPS are the provisions that relate to the management of freshwater, biodiversity and cultural values. The Proposal's consistency with the RPS is discussed in the table below.

Table 12.2: Regional Policy Statement Assessment

RPS Provision	Comment/Assessment
Resource Management Issues of Significance to Iwi Authorities	
Objective RMIA-O1: Resource Management 1. To have regard to the mauri of natural and physical resources to enable hapū and iwi to provide for their social, economic and cultural wellbeing. 2. Kaitiakitanga must be given particular regard and the relationship of hapū and iwi with their ancestral lands, water, sites, wāhi tapu and other taonga (including wāhi tūpuna) must be recognised and provided for through resource management processes.	The Applicant has given effect to this objective by engaging with iwi and hapū throughout the development of the proposal and offering conditions which provide for the active involvement of iwi and hapū throughout the term of consent. For example, iwi / hapū must be provided with an opportunity to input into the draft management plans as well as their review. Further, the Applicant has accepted MTA's recommendations for cultural offsetting and has worked with MTA to develop a draft COMP to be finalised and implemented as conditions of consent. The objective of the COMP is to ensure that there is no net loss of mauri and habitat availability as a result of the proposed activities. It is therefore considered that the proposal is consistent with Policy RMIA-O1.
Policy RMIA-P1: Hapū and iwi involvement in resource management The Regional Council must enable and foster kaitiakitanga and the relationship between hapū and iwi and their ancestral lands, water, sites, wāhi tapu and other taonga (including wāhi tūpuna) through increased involvement of hapū and iwi in resource management processes including: 1. … 2. recognition of existing arrangements and agreements between resource users, local authorities and hapū or iwi. 3. … 4. … 5. … 6. … 7. the Regional Council having regard to iwi management plans lodged with Council. 8. involvement of hapū or iwi in resource consent decision-making and planning processes in the ways agreed in the memoranda of partnership and joint management.	As detailed in Section 7, the Applicant has involved hapū and iwi in the development of the proposal, and is offering consent conditions which enable their ongoing involvement throughout the term of the consent. For example, in addition to providing input into management plans, iwi are afforded an opportunity to comment on any issues as part of the annual report of compliance. It is considered that the proposal is consistent with Policy RMIA-P1
Policy RMIA-P2: Wāhi tapu, wāhi tūpuna and other sites of significance 1 Wāhi tapu, wāhi tūpuna and other sites of significance to Māori identified: a. In the Regional Coastal Plan and district plans, b. as historic reserves under the Reserves Act 1977, c. as Māori reserves under the Te Ture Whenua Māori Act 1993, d. as sites recorded in the New Zealand Archaeological Association's Site Recording Scheme, and e. as registered sites under the Historic Places Act 1993.	There are no wāhi tapu, wāhi tūpuna and other sites of significance to Māori identified via any of the mechanisms recognises in this policy that are affected by the proposed activities. The Applicant has commissioned an Archaeological Assessment for the reservoir area and no such sites were identified through this study. Accidental Discovery Protocols, as recommended in the Archaeological Assessment, are proposed for the construction phase of the project. It is considered that the proposal is consistent with Policy RMIA-P2

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must be protected from inappropriate subdivision, use or development that would cause adverse effects on the qualities and features which contribute to the values of these sites. 3. Potential damage or disturbance (including that caused by inappropriate subdivision, use or development) to wāhi tapu, wāhi tūpuna and other sites of significance to Māori not identified (for confidentiality and sensitivity reasons) by hapū or iwi under (a), above, must be minimised by the Regional Council facilitating the compilation of databases by hapū and iwi to record locations which need to remain confidential. 4. The Regional Council must ensure that resource users and contractors have clear procedures in the event wāhi tapu or wāhi tūpuna are discovered.	
Policy RMIA--P3: The mauri of water 1. The Regional Council must have regard to the mauri of water by implementing RPS-RMIA-P1(1) to (9) and by restricting and suspending water takes in times of minimum flow consistent with Policy LF-FW-P21.	The proposal enables the Council to significantly reduce, if not avoid, the abstraction of water from the Ohau River during times of minimum flow. This is consistent with Policy LF-FW-P21. The Applicant recognises that the abstraction has been identified, via CIA, to have an adverse effect on the mauri of the awa. The Applicant has accepted recommendations for cultural offsetting, via the COMP which, will ensure there is no net loss of mauri as a result of the proposed activities. It is considered that the proposal is consistent with Policy RMIA-P3.
Mauri *Wai Māori (pure water) is essential to hapū and iwi in the Region to ensure activities conducted for cultural purposes, such as spiritual cleansing, baptismal rituals and food gathering, are achievable. He mea nui te Wai-Māori ki ngā hapū me ngā iwi o te Rohe kia hua ai ka taea te whakatutuki i ngā mahi tikanga Māori pērā i te whakanoa, te tohi, me te kohikohi kai.* *Mauri acts as a balancing agent to ensure the lifesupporting qualities within the water are maintained. Ko tā te Mauri he whakatautika kia hua ai ka puritia tonutia ngā āhuatanga tuku oranga o te wai.* *Human activities, application of impure agents, loss of water capacity, and contaminants all affect the ability of the mauri to perform its role effectively, therefore resulting in a standard of water not suitable for hapū and iwi to perform their relevant tikanga Māori or cultural activities associated with its use. Ka pāngia kinotia te mauri me tōna āhei ki te whakatutuki pai i tōna kaupapa e te mahi a te tangata me te whakamahi mea paruparu, te mimiti o te wai hoki, me te uru mai o ngā paru kino. Ko te hua he wai kāore i te pai ki ngā hapū me ngā iwi hei whakatutuki i ō rātou tikanga e pā ana ki te whakamahi i te wai.*	
Policy RMIA-P4 Other Resource Management Issues 1. Management of water quality and quantity throughout the Region does not provide for the special qualities significant to Māori. 2. Access to and availability of clean water to exercise cultural activities such as food gathering and baptismal rituals have diminished.	The proposed water take is consistent with the allocation framework of the One Plan and will avoid, in all but exceptional circumstances, abstraction when the river is below minimum flow. The proposed water take does not affect the quality of the Ohau River. Enhancement and restoration of the lower terrace via the COMP will ensure no net loss, and potentially a net gain of the mauri of the awa and may assist to provide for food gathering and other tikanga in this area.

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	It is considered that the proposal is consistent with Policy RMIA-P4.
Energy, Infrastructure, and Transport	
Objective EIT-O1: Infrastructure and other physical resources of regional or national importance Have regard to the benefits of infrastructure and other physical resources of regional or national importance by recognising and providing for their establishment, operation, maintenance and upgrading.	The Levin Water Supply System and Network is identified as being regionally or nationally important under Policy EIT-P1 ((1)(i) of the RPS. The benefits of the proposal include the ability to provide safe and reliable access to clean drinking water including for a growing population and service area, whilst reducing effects on the Ohau River. It is considered that this objective is an important aspect of the decision making framework for the Application and that the benefits of the proposal need to be afforded due weight in the assessment and determination of the Application.
Policy EIT-P1: Benefits of infrastructure and other physical resources of regional or national importance 1. The Regional Council and Territorial Authorities must recognise the following infrastructure as being physical resources of regional or national importance: i. public water supply intakes, treatment plants and distribution systems 2. The Regional Council and Territorial Authorities must recognise the following facilities and assets as being physical resources of regional or national importance: (b) existing flood protection schemes 3. The Regional Council and Territorial Authorities must, in relation to the establishment, operation, maintenance, or upgrading of infrastructure and other physical resources of regional or national importance, listed in (1) and (2), have regard to the benefits derived from those activities.	As above, the Levin Water Supply is regionally significant and must be recognised as such in this consenting process. The purpose of the proposed activities is to increase the resilience of the drinking water supply and significantly reduce effects on the Ohau River. It is considered that these objectives and policies clearly seek to enable this type of project. It is noted that the subject area is within a flood control and drainage scheme as per RP-SCHED2, and the potential effects of the proposal on this value have therefore been addressed, in consultation with Horizons Rivers Group.
Policy EIT-P2: Adverse effects of other activities on infrastructure and other physical resources of regional or national importance The Regional Council and Territorial Authorities must ensure that adverse effects on infrastructure and other physical resources of regional or national importance from other activities are avoided as far as reasonably practicable, including by using the following mechanisms: 1. ensuring that current infrastructure, infrastructure corridors and other physical resources of regional or national importance, are identified and had regard to in all resource management decision-making, and any development that would adversely affect the operation, maintenance or upgrading of those activities is avoided as far as reasonably practicable, 2. ensuring that any new activities that would adversely affect the operation, maintenance or upgrading of infrastructure and other physical resources of regional or national importance are not located near existing such resources or such resources allowed by unimplemented resource consents or other RMA authorisations, …	It is considered that the consenting approach, as detailed in the introductory sections of this application, is well aligned with the intention of this policy in that there is certainty being sought by the Applicant to ensure that activities are undertaken in a way that is not at risk from other activities, particularly through the use of a designation and appropriate agreements with landowners. Additionally, this is an important policy for implementation by the Regional Council in terms of ensuring that this Regionally Significant Infrastructure is not unduly restricted or affected by surrounding activities.

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4. notifying the owners or managers of infrastructure and other physical resources of regional or national importance of consent applications that may adversely affect the resources that they own or manage.	
Policy EIT-P3: Adverse effects of infrastructure and other physical resources of regional or national importance on the environment In managing any adverse environmental effects arising from the establishment, operation, maintenance and upgrading of infrastructure or other physical resources of regional or national importance, the Regional Council and Territorial Authorities must: 1. recognise and provide for the operation, maintenance and upgrading of all such activities once they have been established, 2. allow minor adverse effects arising from the establishment of new infrastructure and physical resources of regional or national importance, and 3. avoid, remedy or mitigate more than minor adverse effects arising from the establishment of new infrastructure and other physical resources of regional or national importance, taking into account: a. the need for the infrastructure or other physical resources of regional or national importance, b. any functional, operational or technical constraints that require infrastructure or other physical resources of regional or national importance to be located or designed in the manner proposed, c. whether there are any reasonably practicable alternative locations or designs, and d. whether any more than minor adverse effects that cannot be adequately avoided, remedied or mitigated by services or works can be appropriately offset, including through the use of financial contributions.	This Application demonstrates that the adverse effects on the environment of the proposal are no more than minor, and that these have been avoided, remedied or mitigated to the extent reasonably practicable with a significant offsetting package also offered to achieve a net gain with respect to cultural and wetland values. It is considered that the overall effects on the environment of the proposal will be positive. The matters set out in (3), where relevant, have been taken into account and are addressed within the application. It is considered that the proposal is consistent with Policy EIT-P3.
Urban Form and Development	
Objective UFD-O1: The strategic integration of infrastructure with land use Urban development occurs in a strategically planned manner which allows for the adequate and timely supply of land and associated infrastructure.	One of the key drivers for the proposal is to ensure that adequate water supply quantity is available for Levin in accordance with projected growth, and to support residential zoning and housing supply initiatives by the Council. The project clearly contributes to the strategic and well planned delivery of infrastructure and is therefore consistent with this Objective.

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Policy UFD-P1: The strategic integration of infrastructure with land use Territorial Authorities must proactively develop and implement appropriate land use strategies to manage urban growth, and they should align their infrastructure asset management planning with those strategies, to ensure the efficient and effective provision of associated infrastructure.	One of the key drivers for the proposal is to ensure that adequate water supply quantity is available for Levin in accordance with projected growth, and to support residential zoning and housing supply initiatives by the Council. The project clearly contributes to the strategic and well planned delivery of infrastructure. A robust alternatives assessment has been undertaken, and the proposal is considered to be consistent with this Policy.
Land and Freshwater	
Objective LF-FW-O3: Water management Values Surface water bodies and their beds are managed in a manner which safe guards their life supporting capacity and recognises and provides for the Values in RP-SCHED2.	The effects of the proposal on RP-SCHED2 values are specifically addressed in section 9.7 of the application. As detailed therein, it is considered that the proposal ensures that the life supporting capacity of the awa is safe guarded, and that the proposal recognises and provides for those values. The proposal will significantly reduce the impacts of the existing take on the health of the awa and overall will not have a more than minor effect on the Ohau River. It is therefore considered that the application achieves this objective.
Objective LF-FW-O4 Water quality 1. Surface water quality is managed to ensure that: a. water quality is maintained in those rivers and lakes where the existing water quality is at a level sufficient to support the Values in RP-SCHED2 b. water quality is enhanced in those rivers and lakes where the existing water quality is not at a level sufficient to support the Values in RP-SCHED2 c. accelerated eutrophication and sedimentation of lakes in the Region is prevented or minimised (iv) the special values of rivers protected by water conservation orders are maintained. 2. Groundwater quality is managed to ensure that existing groundwater quality is maintained or where it is degraded/over allocated as a result of human activity, groundwater quality is enhanced.	There are potential effects of the proposed construction activities, the diversion and discharge of groundwater and the on-going effect of removing water from the Ohau River by abstraction. However construction effects will be temporary in nature, and along with groundwater diversion and discharge effects, are able to be appropriately managed by way of management plans and conditions of consent. The proposed new take regime is designed to avoid, in all but exceptional circumstances, the need to take water at times of minimum flow and to reduce the effects of the take on the awa overall. For these reasons it is considered that the proposal achieves the water quality objectives including LF-FW-O2 and the policies set out below. In terms of groundwater, the proposal has, at worst, a very local and less than minor effect by diverting groundwater immediately below the reservoir footprint and discharging this to land on the lower terrace. This will be done in a way that utilises this water, which currently enters the lower terrace area as shallow groundwater and / or seeps at the terrace face, to improve the wetland and habitat environment of the lower terrace.
Policy LF-FW-P4: Water Management Areas and Values For the purposes of managing water quality, water quantity, and activities in the beds of rivers and lakes, the catchments in the Region have been divided into Water Management Areas and Water Management Sub-areas in RP-SCHED1. Groundwater has been divided into Groundwater Management Areas in RP-SCHED4. The rivers and lakes and their beds must be managed in a manner which safeguards their life supporting capacity and recognises and provides for the RP-SCHED2 Values when decisions are made on avoiding, remedying or mitigating the adverse effects of activities or in relation to any other function under the Resource Management Act 1991 exercised by the Regional Council or Territorial Authorities. The individual	

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Values and their associated management objectives are set out in the RP-SCHED2 Surface Water Management Values Key and repeated in Table 7.	
Policy LF-FW-P5: Ongoing compliance where water quality targets are met 1. Where the existing water quality meets the relevant RP-SCHED5 water quality targets within a Water Management Sub-area, water quality must be managed in a manner which ensures that the water quality targets continue to be met beyond the zone of reasonable mixing (where mixing is applicable). 2. For the avoidance of doubt: a. in circumstances where the existing water quality of a Water Management Sub-area meets all of the water quality targets for the Sub-area (1) applies to every water quality target for the Sub-area b. in circumstances where the existing water quality of a Water Management Sub-area meets some of the water quality targets for the Sub-area (1) applies only to those water quality targets that are met c. for the purpose of (1) reasonable mixing is only applicable to a discharge from an identifiable location.	
Policy LF-FW-P9: Maintenance of groundwater quality 1. Discharges and land use activities must be managed in a manner which maintains the existing groundwater quality, or where groundwater quality is degraded/over allocated as a result of human activity, it is enhanced. 2. An exception may be made under (1) where a discharge onto or into land better meets the purpose of the RMA than a discharge to water, provided that the best practicable option is adopted for the treatment and discharge system.	
Objective LF-FW-05: Water quantity and allocation Water quantity is managed to enable people, industry and agriculture to take and use water to meet their reasonable needs while ensuring that: 1. For surface water: a. minimum flows and allocation regimes are set for the purpose of maintaining or enhancing (where degraded) the existing life-supporting capacity of rivers and their beds and providing for the other Values in RP-SCHED2 as appropriate b. takes and flow regimes for existing hydroelectricity are provided for before setting minimum flow and allocation regimes for other uses c. in times of water shortage, takes are restricted to those that are essential to the health or safety of people and communities, or drinking water for animals, and other takes are ceased d. the amount of water taken from lakes does not compromise their existing life-supporting capacity e. the requirements of water conservation orders are upheld	This Application contains a comprehensive assessment of alternatives for supply (section 6) and of the reasonable and justifiable need test (section 5.6) including, water efficiency measures. Water harvesting from the Ohau River above median flows and an off-river storage reservoir has been identified as the preferred option. There is no new core allocation being sought by way of this Application, and the new take regime is designed to lessen effects on the Ohau River enhancing the life-supporting capacity of the River. As discussed above in section 9.7 the proposal will also provide for the SCHED2 values. The proposal would also meet the community's needs and increase the resilience of the scheme all while managing the adverse effects such that they are no more than minor, and in the case of wetlands there is a positive outcome.

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f. the instream geomorphological components of natural character are provided for. For the avoidance of doubt this list is not hierarchical. 2. For groundwater…. 3. In all cases, water is used efficiently.	Despite the fact that the supplementary take is classified as a non-complying activity, it is an activity that is enabled under the RPS in terms of the directives to consider alternative sources including water storage and that supplementary allocation can be made available at times of high flow. Further, while the core allocation sought to be able to be abstracted below minimum flow is a non-complying activity as it exceeds the 250 L/person/day limit to be assessed as a Discretionary Activity, it is consistent with the Policy-LF-FW-P21 provision for Essential takes for public water supplies at times of minimum flow. Additionally, the provision of short term abstraction of water for construction of the NZTA Waka Kotahi Otaki to North Levin project contributes to efficiency in the allocation of water. It is considered that the Application serves to achieve this Objective of the RPS in regard to the management of water quantity and serves to give effect to the intent of the RPS.
LF-FW-P15: Reasonable and justifiable need for water Subject to LF-FW-P21, the amount of water taken by resource users must be reasonable and justifiable for the intended use. In addition, the following specific measures for ensuring reasonable and justifiable use of water must be taken into account when considering consent applications to take water for irrigation, public water supply, animal drinking water, dairy shed washdown or industrial use, and during reviews of consent conditions for these activities. … 4. For public water supplies, the following must generally be considered to be reasonable: a. an allocation of 300 litres per person per day for domestic needs, plus b. an allocation for commercial use equal to 20% of the total allocation for domestic needs, plus c. an allocation for industrial use calculated, where possible, in accordance with best management practices for water efficiency for that particular industry, plus d. an allocation necessary for hospitals, other facilities providing medical treatment, marae, schools or other education facilities, New Zealand Defence Force facilities or correction facilities, plus e. an allocation necessary for public amenity and recreational facilities such as gardens, parks, sports fields and swimming pools, plus f. an allocation necessary to cater for the reasonable needs of animals or agricultural uses that are supplied by the public water supply system, plus	As discussed above in section 9.7 this Policy has been recognised as a key part of the planning framework for the Application. Appendix C includes a detailed Technical Memo that sets out an assessment of the proposal against this policy. As concluded therein, it is considered that the proposed water take regime constitutes a reasonable and justifiable use of water, taking into account all factors in Policy LF-FW-P15. It is considered that the project, and this Application, are consistent with this Policy.

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g. an allocation necessary to cater for growth, where urban growth of the municipality is provided for in an operative district plan for the area and is reasonably forecast, plus h. an allocation for leakage equal to 15% of the total of (a) to (h) above.	
Policy LF-FW-P16: Efficient use of water Water must be used efficiently, including by the following measures: 1. requiring water audits and water budgets to check for leakages and water-use efficiency as appropriate 2. requiring the use of, or progressive upgrade to, infrastructure for water distribution that minimises the loss of water and restricts the use of water to the amounts determined in accordance with LF-FW-P15 3. enabling the transfer of water permits 4. promoting water storage 5. raising awareness about water efficiency issues and techniques 6. requiring monitoring of water takes, including by installing water metering and telemetry.	This Application in sections 3.1.3, 4.1.2 and 4.1.5 addresses the matter of the efficient use of water in detail, including improvements to the network and the Demand Management Plan, and also providing short term supply for construction of nationally important infrastructure, so that over-abstraction of nearby water sources can be avoided. It is considered that the Applicant has and is addressing all matters set out in this Policy and it is noted with emphasis that this Policy promotes the use of water storage. The Application is therefore clearly consistent with and enabled by this Policy.
Policy LF-FW-P18: Core allocations and minimum flow 1. The taking of water^ from rivers^ must be managed in accordance with the minimum flows and cumulative core allocations set out in RP-SCHED3. 2. The minimum flows and cumulative core allocations set out in RP-SCHED3 must be set after providing for any takes and flow regimes lawfully established for hydroelectricity generation as at 31 May 2007.	There is no new core allocation being sought by way of this application and the proposed activities continue to be consistent with the core allocation policies of the RPS.
Policy LF-FW-P20: Supplementary water allocation In addition to the core allocations set out in LF-FW-P18, a supplementary allocation from rivers may be provided: 1. in circumstances where water is only taken when the river flow is greater than the median flow, and the total amount of water taken by way of a supplementary allocation does not exceed 10% of the actual flow in the river at the time of abstraction, and 2. in circumstances where it can be shown that the supplementary allocation will not: a. increase the frequency or duration of minimum flows b. lead to a significant departure from the natural flow regime, including the magnitude of the median flow and the frequency of flushing flows c. cause any adverse effects that are more than minor on the RP-SCHED2 Values of the water body or its bed d. limit the ability of anyone to take water under a core allocation e. derogate from water allocated to hydroelectricity generation.	Section 9.3 of this Application sets out a detailed consideration of this Policy in the context of the hydrological assessment of the proposed take regime. The proposed supplementary allocation is enabled by this Policy, despite the fact that it falls to be considered as a non-complying activity under the Regional Plan. For reasons discussed in section 9, including that supplementary allocation will only be taken when the river is above median flow, the supplementary abstraction will not create a significant departure from the natural flow regime, including flushing flows, nor impact the RP-SCHED2 values to a more than minor degree. It will not impact on other persons' ability to take core allocation and will not derogate from water allocation for hydro-electricity - there is no such use on the Ohau River. Therefore, the effects of the proposed abstraction on matters relevant in this Policy are less than minor.

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Policy LF-FW-P21: Apportioning, restricting and suspending takes in times of minimum flow When a river is at or below its minimum flow, takes from it must be managed in the following manner: … 3. Supplementary takes - must cease at a flow specified in their consent conditions and that cessation flow must be higher than the RP-SCHED3 minimum flow such that the requirements of Lf-FW-P20(2)(a) are met. 4. Essential takes - The following core water allocation takes are deemed essential and must be managed in the manner described: b. takes required to meet the reasonable needs of hospitals, other facilities providing medical treatment, marae, schools or other educational facilities, New Zealand Defence Force facilities or correction facilities must be allowed to continue regardless of river flow, but must be required to minimise the amount of water taken to the extent reasonably practicable. c. takes which were lawfully established at the time of Plan notification (31 May 2007) required for industries which, if their take were to cease, would significantly compromise a community's ability to provide for its social, economic or cultural wellbeing or for its health or safety (including the hygienic production and processing of perishable food), must be allowed to continue regardless of river flow, but must be required to minimise the amount of water taken to the extent reasonably practicable d. public water supply takes must be restricted to a total public water consumption calculated as follows: (i) an allocation of 250 litres per person per day for domestic needs, plus (ii) an allocation for commercial use equal to 20% of the total allocation for domestic needs, plus (iii) an allocation which meets the reasonable needs of those facilities and industries listed under (4)(b) and (4)(c) where such facilities and industries are connected to the public water supply system, plus (iv) any allocation necessary to cater for the reasonable needs of animals that are supplied by the public water supply system, plus (v) an allocation for leakage equal to 15% of the total of (i) to (iv) above.	The existing Levin Water supply consent enables abstraction to occur at a reduced rate of 13,000 m^3/day when the river is below minimum flow. One of the key drivers for this Application is to enable the Council to avoid, in all but exceptional circumstances, the need to abstract at times of minimum flow. It is therefore considered that the proposal is consistent with Policy LF-FW-P21 of the RPS. The abstraction amount sought below minimum flow (only to be exercised under exceptional circumstances once the reservoir is constructed) is the same as was determined appropriate at the time the existing consent was granted in accordance with part 4(d) of this policy and therefore is considered to be consistent with this policy.
Objective LF-FW-O6: Beds of rivers and lakes The beds of rivers and lakes will be managed in a manner which: 1. sustains their life supporting capacity 2. provides for the instream morphological components of natural character 3. recognises and provides for the RP-SCHED2 Values 4. provides for infrastructure and flood mitigation purposes.	The proposed activities will enable the life supporting capacity of the bed of the river to be sustained. This is because the potential adverse effects of the proposed activities on the bed of the river and on the Flood Control and Drainage scheme will not be more than minor. The proposed reservoir intake has been designed to ensure that, following construction, there

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The land adjacent to the bed of reaches with a RP-SCHED2 Value of Flood Control and Drainage will be managed in a manner which provides for flood mitigation purposes.	is no change to the morphological components of the natural character. There are no other works directly in the river bed. It is therefore considered that this Objective and related Policies can be achieved in any granting of consent to the applications for activities within the river bed.
Policy LF-FW-P25: General management of the beds of rivers and lakes Activities in, on, under or over the beds of rivers and lakes must generally be managed in a manner which: 1. recognises and provides for the RP-SCHED2 Values for the Water Management Sub-area(s) in which the activity takes place, in the manner described in Policies RPS-LF-FW-P26, RPS-LF-FW-P27 and RPS-LF-FW-P28. 2. avoids any significant reduction in the ability of a river and its bed to convey flood flows, or significant impedance to the passage of floating debris 3. avoids, remedies or mitigates any significant adverse effects on the stability and function of the beds of rivers and lakes, and existing structures including flood and erosion control structures 4. avoids, remedies or mitigates any significant reduction in the habitat diversity, including the morphological diversity, of the river or lake or its bed 5. manages effects on natural character and public access in accordance with the relevant policies in RPS-ECO. Natural character can include the natural style and dynamic processes of the river, such as bed style and width and the quality and quantity of bed habitat 6. provides for the safe passage of fish both upstream and downstream 7. ensures that the existing nature and extent of navigation of the river or lake are not obstructed 8. ensures that access required for the operation, maintenance, and upgrade of infrastructure and other physical resources of regional or national importance is not obstructed 9. provides for continued public access in accordance with RPS-NATC-P3.	
Policy LF-FW-P27: Activities in rivers or lakes and their beds with a Value of Flood Control and Drainage In reaches of rivers or lakes and their beds with a RP-SCHED2 Value of Flood Control and Drainage, activities in, on, under or over the beds of rivers and lakes and on land adjacent to the bed where the Value is located must be managed in a manner which: 1. enables the degree of flood hazard and erosion protection existing at the time of Plan notification (31 May 2007) to be maintained or enhanced 2. addresses adverse effects by: a. in the first instance, avoiding, remedying or mitigating adverse effects on the instream morphological components of natural character and other RP-SCHED2 Values b. providing consent applicants with the option of making an offset	

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c. allowing compensation by way of a financial contribution in accordance with the policies in RP-FC.	
Policy LF-FW-P28: Activities in rivers or lakes and their beds with other RP-SCHED2 Values In sites with RP-SCHED2 Values other than Natural State, Sites of Significance - Cultural, Sites of Significance - Aquatic, or Flood Control and Drainage, activities in, on, under or over the beds of rivers and lakes must be managed in a manner which: 1. in the first instance avoids, remedies or mitigates significant adverse effects on the instream morphological components of natural character and RP-SCHED2 Values 2. provides consent applicants with the option of making an offset 3. allows compensation by way of a financial contribution in accordance with the policies in RPS-FC.	
Policy LF-FW-P29: Essential and beneficial activities Activities in, on, under or over the beds of rivers and lakes that are essential or result in an environmental benefit must generally be allowed, including: 1. the use, maintenance and upgrading of existing infrastructure and other existing physical resources of regional or national importance 2. works designed to maintain or improve the stability and functionality of existing structures 3. the removal of derelict, unlawful or non-functional structures 4. the restoration or enhancement of natural habitats.	
Hazards and Risks	
HAZ-NH-O2: Effects of natural hazard events The adverse effects of natural hazard events on people, property, infrastructure and the wellbeing of communities are avoided or mitigated.	Both the effects of the proposal on the flood hazard within the Ohau River and the effects of potential hazards on the reservoir have been considered in the development of the proposal and assessed within the application (section 9.6). The abstraction will not have an adverse effect on flood carrying capacity and mitigation measures. A Flood Contingency Plan will be developed to mitigate the risks of flooding during construction. The proposed pipe bridge will not result in any structures within the flood channel so does not present any constraint or change to the existing flood carrying capacity of the river. In the case of a credible worst case-scenario breach of the reservoir, the risk of which is assessed as being extremely low, there is no risk to infrastructure and the risk to life is also considered to be extremely low. It is therefore considered that effects in this regard are acceptable. More importantly in terms of the overall effects of the proposed activities is that the

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	proposed storage will add resilience within the Levin Water Supply network. This will assist the Council in being able to provide a lifeline service to its community during and after natural hazards events. The sensitivity of water networks to natural hazards has been an extremely significant factor in the recent cyclone and flooding events in Aotearoa New Zealand and the ability to draw on reserves and stored supply increases resilience significantly. It is therefore considered that the proposal achieves this important objective.

Section 104(1)(b) Any Relevant Provisions of -- (vi) a Plan or Proposed Plan - Regional Plan

The Regional Plan addresses the same topics as those covered by the RPS discussed above. Where relevant (and to avoid repetition), the analysis below refers back to the analysis of the same subject matter in relation to objectives and policies in the RPS discussed above. The proposal's consistency with the RPS is discussed in the table below.

Table 12.3: Regional Plan Objective and Policy Assessment

Regional Plan Provision	Comment/Assessment
LF-WETL-Wetlands	
The loss of extent of natural inland wetlands is avoided, their values are protected, and their restoration is promoted, except where: 1. the loss of extent or values arises from any of the following f. the maintenance or operation of specified infrastructure, or other infrastructure (as defined in the Resource Management (National Environmental Standards for Freshwater) Regulations 2020) 2. the Regional Council is satisfied that: a. the activity is necessary for the construction or upgrade of specified infrastructure; and b. the specified infrastructure will provide significant national or regional benefits; and c. there is a functional need for the specified infrastructure in that location; and d. the effects of the activity are managed through applying the effects management hierarchy;	The proposal will result in the loss of a small marginal wetland of low ecological value, as well as the restoration and enhancement of a large area of wetland on the lower terrace. As detailed in Section 8, the proposal is for specified infrastructure that will provide significant regional benefits. It has been demonstrated (Appendix K) that there is a functional need for the specified infrastructure in that location and the effects management hierarchy has been applied as detailed in Section 9.5.3. Importantly, although the proposal will result in the loss of a small marginal wetland of low ecological value, the proposal includes substantial offsetting involving the restoration and enhancement of a large area of wetland on the lower terrace which will deliver a net gain in wetland biodiversity. The Regional Council can therefore be satisfied that there will be no net loss of extent of natural inland wetlands and the matters that need to be satisfied for grant of consent have been met in accordance with this Policy.
LF-LW - Discharges to Land and Water	
Objective LF-LWO2: Management of discharges to land and water and land uses affecting groundwater and surface water quality The management of discharges onto or into land (including those that enter water) or directly into water and land use activities affecting groundwater and surface water quality in a manner that:	The potential effects of the proposed discharges during construction, such as the diversion and discharge of groundwater, will be temporary and are able to be appropriately managed by way of management plans and conditions of consent. The proposed operational discharges will have minimal environmental effects, and the effects

Regional Plan Provision	Comment/Assessment
1. safeguards the life supporting capacity of water and recognises and provides for the Values and management objectives in RP-SCHED2, 2. provides for the objectives and policies of RPF-LF as they relate to surface water and groundwater quality, and 3. where a discharge is onto or into land, avoids, remedies or mitigates adverse effects on surface water or groundwater.	associated with discharge of sediment are well understood and can and will be managed appropriately by way of conditions of consent and management plans such that they will be no more than minor. As discussed above in relation to the RPS it is considered that the proposal will safeguard the life supporting capacity of the Ohau River and recognises and provides for the values in RP-SCHED2 which, are specifically addressed in section 9.7. As set out above it is also considered that the proposal provides for the objectives and policies of the RPF-LF. The discharges do not introduce new contaminants into the environment, and are necessary to enable the proposal which is consistent with other objectives and policies of the RPS. As discussed above, this Application contains a comprehensive assessment of alternatives for supply (section 6) and it is considered that this proposal has adopted the Best Practicable Option. Further, the proposal has been developed so as to, as far as reasonably practicable, avoid effects on sensitive environments, and to remedy or mitigate any on-going effects in the river. An assessment of the Application with regard to the NPSFM is included in section 12.1 of the Application. In summary it is considered that the Proposal is consistent with the objective and policies of the NPSFM, particularly since the proposal will significantly reduce if not avoid the need to take water at times of low flow and to reduce the effects of the take on the awa overall. For these reasons it is considered that the proposal achieves the objectives and the policies of the NPSFM20. It is therefore considered that the proposed discharges are consistent with the water quality provisions of the regional plan.
Policy LF-LW-PF: Consent decision making for discharge to water When making decisions on resource consent applications, and setting consent conditions, for discharges of water or contaminants into water, the Regional Council must specifically consider: 1. the objectives and RPS-LF-FW-P5 to RPS-LF-FW-P9 and RPS-LF-FW-P13 of RPS-LF, and have regard to: 2. avoiding discharges which contain any persistent contaminants that are likely to accumulate in a waterbody or its bed, 3. the appropriateness of adopting the best practicable option to prevent or minimise adverse effects in circumstances where: a. it is difficult to establish discharge parameters for a particular discharge that give effect to the management approaches for water quality and discharges set out in RPS-LF, or b. the potential adverse effects are likely to be minor, and the costs associated with adopting the best practicable option are small in comparison to the costs of investigating the likely effects on land and water, and 4. the objectives and policies of RPS-RMIA, RPS-EIT, RPS-ECO, RPS-HCV, RPS-NATC, RPS-NFL, RPS-HAZ, and RP-IP to the extent that they are relevant to the discharge*.	
Policy LF-LW-P5: Consent decision-making for discharges to land When making decisions on resource consent applications, and setting consent conditions, for discharges of contaminants onto or into land the Regional Council must have regard to: 1. the objectives and policies of RPS-LF regarding the management of groundwater quality and discharges, 2. where the discharge may enter surface water or have an adverse effect on surface water quality, the degree of compliance with the approach for managing surface water quality set out in RPS-LF, 3. avoiding as far as reasonably practicable any adverse effects on any sensitive receiving environment or potentially incompatible land	

Regional Plan Provision	Comment/Assessment
uses, in particular any residential buildings, educational facilities, churches, marae, public areas, infrastructure and other physical resources of regional or national importance identified in RPS-EIT-P1, wetlands, surface water bodies and the coastal marine area, 4. the appropriateness of adopting the best practicable option to prevent or minimise adverse effects in circumstances where: a it is difficult to establish discharge parameters for a particular discharge that give effect to the management approaches for water quality and discharges set out in RPS-LF, b the potential adverse effects are likely to be minor, and the costs associated with adopting the best practicable option are small in comparison to the costs of investigating the likely effects on land and water, 5. avoiding discharges which contain any persistent contaminants that are likely to accumulate in the soil or groundwater, and 6. the objectives and policies of RPS-RMIA, RPS-EIT, RPS-ECO, RPS-HCV, RPS-NATC, RPS-NFL, RPS-HAZ, and RP-IP to the extent that they are relevant to the discharge.	
Policy LF-LW-P7: Options for discharges to surface water and land When applying for consents and making decisions on consent applications for discharges of contaminants into water or onto or into land, the opportunity to utilise alternative discharge options, or a mix of discharge regimes, for the purpose of mitigating adverse effects, applying the best practicable option, must be considered, including but not limited to: 1. discharging contaminants onto or into land as an alternative to discharging contaminants into water, 2. withholding from discharging contaminants into surface water at times of low flow, 3. adopting different treatment and discharge options for different receiving environments or at different times (including different flow regimes or levels in surface water bodies).	
Policy LF-FW-P12: Consent decision making requirements from the National Policy Statement for Freshwater Management 1. This policy applies to any application for the following discharges (including a diffuse discharge by any person or animal): a. a new discharge;– b. a change or increase in any discharge of any contaminant into fresh water, or onto or into land in circumstances that may result in that	

Regional Plan Provision	Comment/Assessment
contaminant (or, as a result of any natural process from the discharge of that contaminant, any other contaminant) entering fresh water. 2. When considering any application for a discharge the Regional Council must have regard to the following matters: a. the extent to which the discharge would avoid contamination that will have an adverse effect on the life-supporting capacity of fresh water including on any ecosystem associated with fresh water; and b. the extent to which it is feasible and dependable that any more than minor adverse effect on fresh water, and on any ecosystem associated with fresh water, resulting from the discharge would be avoided. This clause of the policy does not apply to any application for consent first lodged before the National Policy Statement for Freshwater Management 2011 took effect on 1 July 2011. 3. When considering any application for a discharge the Regional Council must have regard to the following matters: a. the extent to which the discharge would avoid contamination that will have an adverse effect on the health of people and communities as affected by their secondary contact with fresh water; and b. the extent to which it is feasible and dependable that any more than minor adverse effect on the health of people and communities as affected by their secondary contact with fresh water resulting from the discharge would be avoided. This clause of the policy does not apply to any application for consent first lodged before the National Policy Statement for Freshwater Management 2014 took effect on 4 July 2014.	
Takes, Uses and Diversions of Water and Bores	
LF-TUD: Regulation of takes, uses and diversions of water The regulation of takes, uses and diversions of water in a manner that: a. recognises and provides for the Values and management objectives in RP-SCHED2, and b. provides for the objectives and policies of RPS-LF-FW as they relate to surface water and groundwater use and allocation	The water management framework set out in the Regional Plan has been a key policy driver in the development of the proposal. All of the relevant matters addressed within these provisions are considered in detail within this Application and for the reasons discussed above as well as in relation to the RPS it is considered that the proposal achieves the objective and is consistent with the policies.

Regional Plan Provision	Comment/Assessment
LF-TUD-P13: Consent decision-making for takes and uses of surface water and groundwater When making decisions on resource consent applications under s104-104D RMA, and setting consent conditions, for takes and uses of surface water or groundwater the Regional Council must: (a) seek to avoid any adverse effects on other lawful activities, particularly on other surface water takes, including takes allowed by s14(3)(b) of the RMA, and groundwater takes from properly-constructed, efficient and fully-functioning bores (as described in RP-LF-TUD-P16 and RP-LF-TUD-P17), (b) enable non-consumptive uses of water including the use and recycling of water, and (c) have regard to the objectives and policies of RPS-RMIA, RPS-EIT, RPS-LF, RPS-ECO, RPS-HCB, RPS-NATC, PRS-NFL, RPS-HAZ and RP-IP to the extent that they are relevant to the activity.	
LF-TUD-P14: Consideration of alternative water sources When making decisions on consent applications to take surface water, the opportunity to utilise alternative sources such as groundwater, water storage, water harvesting (including during periods of high flow in a river) and the recycling of water must be considered.	
LF-TUD-P20: Monitoring requirements of consent holders **Water takes must generally be subject to the following monitoring requirements:** 1. the installation of a pulse-count capable water meter on all water takes that are allowed by way of a resource consent, in order to monitor the amount of water taken (b) the installation of a Regional Council compatible telemetry system on surface water takes greater than 750 m^3 /d, and on groundwater takes greater than 750 m^3 /d where the groundwater is highly interconnected with surface water 2. the installation of a Regional Council compatible telemetry system on other groundwater takes greater than 4,000 m^3 /d 3. Appropriate water quality monitoring, including conductivity monitoring on groundwater takes located within 5 km of the coast, or on a nearby monitoring bore 4. the installation of a Regional Council compatible telemetry system on consented surface water takes where: a. the amount of water taken, when assessed in combination with all other water takes upstream, exceeds 15% of the estimated one-day mean annual low flow, or	These matters have been discussed in section 4.1.3 and are to be addressed as appropriate by way of conditions imposed by the consent authority on any grant of consent.

Regional Plan Provision	Comment/Assessment
b. the amount of water taken from a Water Management Sub-area as identified in RP-SCHED1 exceeds 15% of the one-day mean annual low flow for that Sub-area.	
LF-AWBD: Activities in Artificial Watercourses, Beds of Rivers and Lakes, and Damming	
LF-AWBD-O5: Regulation of structures and activities in artificial watercourses and in the beds of rivers and lakes, and damming. The regulation of structures and activities in artificial watercourses and in the beds of rivers and lakes, and damming, in a manner that: 1. safeguards life supporting capacity, and recognises and provides for the Values and management objectives in RP-SCHED2, and 2. has regard to the objectives and policies of Chapter 5 that relate to structures and activities in artificial watercourses and in the beds of rivers and lakes, and damming.	As has been discussed above, the proposed activities will enable the life supporting capacity of the bed of the river to be safeguarded, particularly in the context of the purpose of the in-river activities being for human health and drinking water purposes. The potential effects of the proposed activities on the bed of the river and on the Flood Control and Drainage scheme will not be more than minor, nor will there be any effects on fish passage. Potential temporary effects on fish passage during construction will be managed by providing an alternate channel around the construction area and undertaking fish relocation at the commencement and completion of works. It is therefore considered that this objective can be achieved in any granting of consent to the applications for activities within the river bed.
LB-AWBD-O6: Fish Passage The passage of fish is maintained, or is improved, by instream structures, except where it is desirable to prevent the passage of some fish species in order to protect desired fish species, their life stages, or their habitats.	
Policy LF-AWBD-P22: Consent decision-making for activities in, on, under or over the beds of rivers and lakes (including modified watercourses but excluding artificial watercourses) When making decisions on resource consent^ applications, and setting consent conditions, for activities in, on, under or over the bed of a river or lake (including modified watercourses but excluding artificial watercourses) the Regional Council must have regard to the extent to which the activity is consistent with best management practices, 1. seek to avoid where reasonably practicable any adverse effects on any other lawful activity in, on, under or over the bed of the river or lake, including existing structures, 2. have regard to whether the activity is of a temporary nature or is associated with necessary maintenance work, 3. have regard to the objectives and policies of RPS-RMIA, RPS-EIT, RPS-LF, RPS-ECO, RPS-HCB, RPS-NATC, PRS-NFL, RPS-HAZ and RP-IP to the extent that they are relevant to the activity, and 4. have regard to the matters in RP-LF-LW-P12.	

Section 104(1)(b) Any Relevant Provisions of -- (vi) a Plan or Proposed Plan - District Plan

As already described, the district council planning approvals for the project will be sought separately. The activities proposed for the Levin Water Supply Water Harvesting and Resilience Project are generally enabled under the Horowhenua District Plan network utility provisions, and not otherwise restricted due to the nature of and zoning for the site (being part of the reason for choosing the site

as a first step in avoiding significant adverse effects on the environment). It is considered that there are no particular matters arising in relation to the District Plan provisions in terms of the assessment and determination of this regional consent application, and that the proposal is consistent with and achieves the intent of the objectives and policies of the District Plan.

For reference, the particular District Plan provisions considered relevant to the project are:

Table 12.4: Relevant Objectives and Policies of the District Plan

District Plan Provisions
Matters of Importance to Tangata Whenua
Objective 1.1.1 Active Participation
To provide Tāngata Whenua with opportunities to actively participate in resource management processes (including decision making) on matters that have the potential to affect their cultural values and well-being.
Policy 1.1.3
Ensure that where relevant, the interests of Tāngata Whenua are taken into account when considering the sustainable use and development of the land, waterways, coastal areas, resources and other taonga.
Policy 1.1.5
Recognise the authorised and mandated Iwi representatives for the purpose of resource management engagement.
Objective 1.2.1 Relationship of Tāngata Whenua
To recognise and provide for the relationship of the Tāngata Whenua of Horowhenua, and their culture and traditions (including mauri), with their ancestral lands, coastal areas, waterways, heritage landscapes and cultural sites, wāhi tapu, wāhi tūpuna and other taonga.
Policy 1.2.3
Recognise the spiritual and cultural values held by Māori and their traditional practices in the management of natural and physical resources.
Policy 1.2.5
Recognise the desire of Tāngata Whenua to maintain and enhance their traditional relationship with the natural environment.
Objective 1.3.1
Sites of Cultural Significance
To protect areas and sites of cultural significance, wāhi tapu, wāhi tūpuna and other taonga from the adverse effects of inappropriate subdivision, use, and development of resources.
Natural Hazards
Objective 8.1.1 Risks and Adverse Effects of Natural Hazards
The adverse effects of natural hazards on people, property, the environment and the wellbeing of communities are avoided or mitigated.
Policy 8.1.6
Flood hazard avoidance must be preferred to flood hazard mitigation.
Policy 8.1.8
Avoid, where practicable, the siting of new critical infrastructure and services within areas of significant risk from natural hazard events.

District Plan Provisions
Utilities and Energy
Objective 12.1.1 Network Utilities
To protect and provide for the establishment, operation, maintenance and upgrading of network utilities, while avoiding, remedying or mitigating adverse effects on the environment.
Policy 12.1.2
Enable the establishment, operation, maintenance and upgrading of essential network utilities.
Policy 12.1.3
Avoid, remedy or mitigate the adverse environmental effects arising from the establishment, construction, operation, maintenance and upgrading of network utilities.
Policy 12.1.5
Ensure the establishment, operation, maintenance and upgrading of network utilities does not compromise the health and safety of the community.
Policy 12.1.6
Consider the locational, technical and operational requirements of network utilities and the contribution they make to the functioning and well-being of the community in assessing their location, design and appearance.

Section 104(1)(c) any other matter the consent authority considers relevant and reasonably necessary to determine the application

There are no other matters which are considered relevant and reasonably necessary to determine the application. There are no iwi environmental management plans that are relevant to the site, awa or project location.

Section 104(3)(a)(ii) A consent authority must not, when considering an application, have regard to any effect on a person who has given written approval to the application.

Affected party approvals have not been sought.

The Applicant requests that this application be publicly notified.

Section 104D RMA Gateway Test Assessment

The Application falls to be considered as a non-complying activity under the One Plan. Specifically, the proposed abstraction of water above core allocation and abstraction of supplementary allocation as well as the proposed planting and restoration in and around wetlands are non-complying activities under the One Plan and NESFW.

Therefore, the consent authority must not grant consent unless it is satisfied that either the adverse effects of the activity on the environment (other than any effect on a person who has given written approval to the application) will be minor or the application will not be contrary to the objectives and policies of the One Plan.

The two limbs of s104D above are often referred to a 'gateway' or 'threshold' tests. Importantly, only one of these tests needs to be satisfied for a consent authority to be able to grant consent having subsequently considered the application(s) in accordance with the matters set out in s.104 of the RMA.

On the basis of the conclusions reached in section 9 of this AEE, when the environmental improvements set out in the proposed offsetting conditions are taken into account, the Applicant considers that the adverse effects on the environment will be minor and therefore no more than minor thus meeting the first section 104D gateway test. In particular:

- The abstraction of water is within the regional allocation framework and provided for in the RPS and Regional Plan and therefore has effects which are no more than minor. Once the reservoir is

constructed, abstraction below minimum flow will be avoided, except in exceptional circumstances and conditions are offered to mitigate effects as far as possible.

- The effect on natural inland wetlands will be no more than minor. While one natural inland wetland of marginal classification will be affected, it has been assessed as being of limited ecological value. The ecological assessment has found that restoration of the wetland areas on the lower floodplain (as proposed) will easily mitigate the loss of the affected wetland and will "very substantially outweigh" the minor adverse effects associated with the loss of the small, highly modified "marginal" wetland.
- The discharges which form part of the proposal are essentially for clean, river water or groundwater to be returned to the river under very infrequent circumstances. Given this, and that there are no contaminants that will be introduced to the system, the effect of any discharges is less than minor.
- Temporary construction effects are able to be avoided, remedied or mitigated through the development and implementation of construction management plans incorporating measures to manage erosion and sediment control; spill prevention and response; fish management and relocation; riparian planting; and flood contingency.
- The constructed infrastructure within the river corridor will not impact fish passage or the natural character of the river and will not impact passage of flood flows.

The Applicant further considers that the Application is not contrary to the objectives and policies of the One Plan. Rather, the proposal is one that the One Plan seeks to enable, particularly through the ability to provide supplementary allocation as per Policy LF-FW-P20 of the RPS and encouragement of the use of alternative sources of water including water harvesting and water storage as per Policy LF-TUD-P14 of the Regional Plan. This is in addition to the provisions discussed above relating to climate change resilience, giving effect to Te Mana o te Wai and regionally significant infrastructure and reasonable and justifiable use of water. A fulsome detailed assessment of all relevant objectives and policies of both the RPS and the Regional Plan is included in section 12.1 of this Application, demonstrating that there are no provisions with which the proposal is contrary.

It is considered that there is no section 104D RMA reason that consent to the application cannot be granted and that the Application meets both 'gateway tests' for non-complying activities.

In relation to section 105 of the RMA, the conclusions reached is that the proposed discharges will have a minor or less than minor impact. As discussed in section 6 the Applicant has thoroughly assessed the alternative options to achieve the key drivers of this project and concluded that this proposal is the best option to meet the community's current and future needs, reduce the effect of the abstraction on the river, and improve the resilience of the water supply scheme.

In relation to section 107 of the RMA, the proposed discharges to the environment do not give rise to the type and/or level of adverse effects set out in section 107 of the RMA (noting that the assessment is to be undertaken “after reasonable mixing”). On that basis, section 107 of the RMA does not create any impediment to granting the consents applied for.

12.2 Particular Part 2 RMA Considerations

All of the matters specified in section 104 of the RMA to which the consent authority must ‘have regard to’ are subject to Part 2 of the RMA which sets out the purpose and principles of the RMA and which are central to the determination of this application.

However, recent case law has altered the role of Part 2 in assessing resource consents applications under section 104 of the RMA28. Now, decision-makers should usually only consider Part 2 when making decisions on resource consents, particularly if the decision-maker considers that the relevant plan has not been competently prepared. If however, the relevant plan provisions have clearly given effect to Part 2, there may be no need to refer back to Part 2 to exercise an overall broad judgment on the application.

It is considered that the provisions of the One Plan do not contain deficiencies that would suggest a misalignment with Part 2, such that Part 2 should be considered in this instance.

However, for completeness, an analysis of the in relation to the Part 2 of the RMA is set out below. It concludes that the proposal is consistent with the overall sustainable management purpose of the RMA.

Section 5 of the RMA – Purpose of the Act

The cornerstone of Part 2 is the Purpose of the RMA as set out in section 5(1), which is: "*To promote the sustainable management of natural and physical resources*."

Section 5(2) of the RMA defines sustainable management as:

> *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 wellbeing 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.*

The overarching intention of the resource consent application process is to ensure that the proposed activities are consistent with the purpose of the RMA.

In terms of section 5 of the RMA, the Application will enable people and communities to provide for their social, economic, and cultural well-being and for their health and safety by providing drinking water. The positive effects of the proposal are detailed throughout this AEE and in summary include:

- The ability to provide for the health and wellbeing of current and future Levin community via the provision of safe drinking water.
- The ability to improve the resilience of the scheme to climate variations, climate change and natural disasters through the provision of storage, consistent with the direction of the Regional Policy Statement and Regional Climate Risk Assessment.
- The ability to reduce the effect of the abstraction on the River at times of minimum flow, being an effect that is currently authorised by the existing resource consent.
- The proposed restoration and enhancement that will occur on the lower terrace of the reservoir site.

Sustainable management enables the use and development of resources while ensuring that the circumstances in section 5(2)(a)-(c) are able to be satisfied.

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[28] *Environmental Defence Society Incorporated v The New Zealand King Salmon Company Limited & Ors [2014] NZSC 38 and RJ Davidson Family Trust v Marlborough District Council [2018] NZCA 316*

In terms of sustaining the potential of the water resources to meet the needs of future generations, the project is intended to meet the increasing demand for drinking water by present and future generations and can be achieved in a manner that is not only sustainable but will also reduce the effects on the Ohau River.

Based on the conclusions reached in this AEE, the life supporting capacity of air, water, soil and ecosystems will be safeguarded. The proposal will reduce the existing impacts on the Ohau River and any adverse effect on the river environment will be no more than minor. The impacts on the wetlands are also assessed as being no more than minor but irrespective, the Applicant has offered a cultural and biodiversity offsetting package to restore and enhance the quality and extent of wetlands in the area to provide a net gain in wetland values. The life supporting capacity of air and soils will not be impacted by this project.

The Applicant has sought in the first instance to avoid adverse effects in the design of the project, particularly where adverse effects have been raised by iwi / hapū and other stakeholders during consultation. The Applicant has sought to remedy and mitigate all other effects or otherwise offset any residual effects.

Section 6 of the RMA – Matters of National Importance

Section 6 of the RMA sets out the matters of national importance that must be recognised and provided for in managing the use, development and protection of natural and physical resources as follows:

- *(a) The preservation of the natural character of the coastal environment (including 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 Māori and their culture and traditions with their ancestral lands, water, waahi tapu, and other tāonga;*
- *(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*

Most aspects of section 6 of the RMA are relevant to the Application.

In terms of section 6(a), the proposal is located within the Ohau River and wetlands however, the proposal is not considered to inappropriately impact the natural character of these environs. This is particularly so given the abstraction of drinking water has been occurring for many years, the objectives and policies in the relevant lower order statutory instruments (discussed above) recognise and provide for the type of activities proposed and the project will reduce the current impacts of abstraction on the Ohau River during low flows and also provide a net gain in terms of wetland values.

In terms of section 6(b), no 'outstanding natural features and landscapes' are proximate to the application site, and none will be impacted by the proposal.

In terms of section 6(c), no areas of significant indigenous vegetation will be affected by the project and the effect of the project on the surrounding wetlands is assessed as being minor. Irrespective of this conclusion, the Applicant has offered a cultural and biodiversity offsetting package to restore and enhance the quality and extent of wetlands in the area to provide a net gain in wetland values.

In terms of section 6(d), there will be no impacts on public access to waterbodies as a result of the proposal.

In terms of sections 6(e), (f) and (g), as detailed in sections 7 and 9.1 the Applicant has sought to provide for the relationship of Māori and their culture and traditions with their ancestral lands, water, waahi tapu, and other taonga by engaging with iwi throughout this project. The Applicant resourced Muaūpoko to prepare the March 2023 CIA and resourced Raukawa hapū to engage the Catalyst Group to provide technical support in considering the project.

This engagement will continue with Muaūpoko and Raukawa hapū to ensure that these sections of the RMA are appropriately addressed in relation to the ongoing operation of the project.

The Applicant has designed and developed the project, including the mitigation and offsetting proposed, to address the issues and concerns raised in feedback and kōrero received during engagement with iwi and hapū as well as in the March 2023 CIA prepared by Muaūpoko.

The Applicant has accepted all of the proposed management and mitigation measures proposed by Muaūpoko in the CIA and incorporated these into the proposal.

HDC has worked with MTA to develop a Cultural Offsetting Management Plan (COMP). The primary objective of the COMP is ensuring no net loss, and preferably a net gain of mauri of the Ohau awa and habitat including, wetlands, is achieved. While there are many ecological benefits of the proposed COMP initiatives, the COMP is first and foremost a means of addressing cultural effects of the proposal.

The Applicant proposes consent conditions as a means to support iwi and hapū roles as kaitiaki. For instance, through providing opportunities for input into management plans and their reviews, the further development and implementation of the COMP and providing opportunities to comment on annual compliance reports. Conditions requiring transparency of this feedback and how it has been incorporated into relevant documents and the management of the system are also included. Further, iwi and hapū are to be notified in the event of an emergency or exceptional water take and must be kept informed throughout.

To the extent any additional cultural effects are identified by Muaūpoko or Raukawa hapū during this consenting process the Applicant will work with iwi and hapū to develop mitigation measures to address those effects and ensure that the requirements in sections 6(e) – (g) of the RMA are appropriately addressed in relation to the project.

In terms of section 6(h), the activities can be designed to avoid any potential adverse effects arising. The abstraction will not have an adverse effect on flood carrying capacity of the Ohau River and mitigation measures including, A Flood Contingency Plan will be developed to mitigate the risks of flooding during construction. With respect to the reservoir, in the case of a credible worst case-scenario breach of the reservoir, the risk of which is assessed as being extremely low, there is no risk to infrastructure and the risk to life is also considered to be extremely low. The proposal will add resilience within the Levin Water Supply network allowing the Council to provide a lifeline service to its community during and after natural hazards events.

Based on the above, the project is not contrary to any of the matters of national importance set out in section 6 of the RMA.

Section 7 of the RMA – Other Matters

Section 7 of the RMA sets out the matters that particular regard must be had to in managing the use, development and protection of natural and physical resources as follows:

(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:

(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.

Most aspects of section 7 of the RMA are relevant to the Application.

With respect to section 7(a), as discussed in Section 7 and 9.1, the Applicant has sought to provide a role for iwi and hapū as kaitiaki by undertaking extensive consultation with iwi / hapū, the feedback from which has shaped the design of the project in terms of both the key elements of the project (such as significantly reducing takes below low flows) as well as proposed mitigation (such as the enhancement and restoration of wetlands).

The Applicant proposes to support iwi and hapū in exercising their role as kaitiaki through conditions which, for example, enable iwi and hapū to prepare the final COMP which, will detail the programme of actions required to achieve the offsetting, approve suitably qualified persons in relation to the COMP, for example those reviewing the COMP undertaking tikanga and cultural protocols at the site, contribute to the preparation of the Management Strategy, receive notification of emergency and exceptional abstractions and provide input on the Water Supply and Reservoir Operational plan, Water Demand Management Plan and In-River and Riparian Works Integrated Construction Management Plan and other Construction Management Plans.

The matters listed in section 7 (aa), (b), and (g) form part of the Applicant's proposed management of the ongoing operation of the Ohau drinking water scheme. This includes the short-term supply of water to NZTA Waka Kotahi to assist with the construction of the Ō2NL project.

The Applicant seeks to manage resources in accordance with the ethic of stewardship. It is in the Applicant's interests to manage and use resources in an efficient manner, all of which recognises the finite characteristics of natural and physical resources and the potential for unsustainable resource use if not managed and controlled appropriately. As detailed in section 3.1.3 the Applicant is required to assess and report on drinking water network efficiencies under the Water Services Act and currently (and will continue to) operate the system in accordance with the Water Demand Management Plan (updated as part of this application) which seeks to drive efficiency of use. Further, the Council has a programme of actions planned for addressing water efficiency and water demand and ensuring that water is used efficiently and effectively.

In relation to section 7(d) and (f), the Applicant has proposed measures to ensure the intrinsic values of ecosystems are not compromised, and its activities will improve the quality of the environment as a result of significantly reducing the takes during low flows and restoring and enhancing wetland areas to provide a net gain in wetland values.

Finally, section 7(i) is particularly relevant to the current application. As discussed in sections 3.1.1 and 5.1, the proposed reservoir and the ability to harvest water for storage is a critical step in addressing the high-extreme risks of the impact of climate change on the availability of drinking water faced by the district.

Section 8 of the RMA – Treaty of Waitangi

Section 8 of the RMA states:

> *In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti ō Waitangi).*

The requirement to take into account the principles of the Treaty of Waitangi is an obligation on those exercising functions and powers under the RMA, including in this case the Manawatū-Wanganui Regional Council making a decision on this application.

The Applicant acknowledges the special status of iwi and hapū and the relationship they have with their taonga tuku iho (inherited treasures). The Applicant also recognises that the proposal is dependent on the use of resources that have spiritual and cultural significance to iwi and hapū.

The Applicant continues to work with iwi and hapū in a manner that is intended to be consistent with the principles of the Treaty of Waitangi. The particular steps that the Applicant has taken to work with iwi / hapū have been discussed in Section 7 of this AEE and as summarised above.

13 SUMMARY AND CONCLUSION

The reasons for this application are:

- To reduce the need to take from the river when it is below minimum flow thereby reducing the effects of the take on the River;
- To provide long term supply to Levin to meet growth projections which are significantly greater than when the existing Levin water supply consent was granted;
- To provide resilience within the Levin drinking water supply network by introducing large scale water storage and reducing risk associated with drought/low flow, high flow and highly turbid source water and emergency supply;
- To reduce the need to abstract large volumes of water from the existing intake structure, given sedimentation issues and the need to periodically scarify the river bed;
- To enable the construction, maintenance and operation of a new intake on the Ohau River and large off-river reservoir to be able to harvest and store water for later supply to the community;
- To provide flexibility and optionality within the water take permit structure to ensure security of supply and efficient use of resources and existing infrastructure by:
  - Providing flexibility between the two intake sites (being the existing intake site and a new reservoir intake site).
  - Ability to take the full consented volume from the new reservoir intake in emergency situations.

- Providing for a short term abstraction of water for construction of the Waka Kotahi Otaki to North Levin project in order to enable efficient allocation of water.

This proposal represents a significant investment by Council (in both water metering and leakage management within the network, and in bulk off-river water storage) to ensure that it is able to provide for the water supply needs for its community while reducing, as far as practicable, the effects of abstraction on the awa; and to provide for growth and improve the resilience of the supply. The proposal has been developed by Council through engagement with its Te Tiriti Partners and stakeholders to ensure that an affordable and sustainable water supply is developed which gives effect to the fundamental principle of Te Mana o te Wai.

Resource consent is required for the Levin Water Supply Water Harvesting & Resilience Project as a non-complying activity for a suite of activities necessary to enable the construction, operation and maintenance of the water supply scheme. The Applicant has requested public notification recognising the public interest in the Ohau Awa and the scale and significance of the proposal. As demonstrated within this Application, the potential adverse effects of the proposal are considered to be no more than minor, and the proposal is considered to be consistent with, and give effect to, all relevant objectives and policies of national and regional planning instruments. There are considered to be significant positive social/community and environmental benefits associated with the proposal. It is therefore considered that the proposal is consistent with the sustainable management purpose of the Resource Management Act.

Appendix A

LEVIN WATER SUPPLY - WATER SUPPLY AUGMENTATION OPERATION FRAMEWORK

Levin Water Supply

Water Supply Augmentation Operational Framework
March 2023

Horowhenua District Council

REVISION 3

EXECUTIVE SUMMARY

This Water Supply Augmentation Operational Framework has been developed to assess options and identify a recommended pathway for securing sufficient drinking water to meet Levin's reasonable needs for the foreseeable future and to improve the security and resilience of the drinking water supply.

The Levin water supply currently sources its drinking water direct from the Ōhau River, with treatment to meet the New Zealand Drinking Water Standards. While there is sufficient water available to meet current needs, the community is experiencing significant growth, and this is expected to continue in the medium term. Existing resource consents for the scheme do not provide sufficient allocation to meet projected growth needs. In addition, the scheme relies on abstraction from the river during times when the river is at or below minimum flow and is vulnerable to dirty source water in high flow periods.

This report assesses drinking water requirements to meet growth demands and to improve the resilience of the supply and adopts a 50-year planning timeframe for consideration of options. It considers alternative water sources to identify a preferred option and recommended framework for meeting supply needs. This report is focused on source water supply augmentation only. Treatment and reticulation / network management components of the scheme are outside of the scope of this document.

The risks and limitations identified for the existing supply are as follows:

	Current Status	**Key Issues, Constraints, Risks**
Resource Consents	Consent secured to 2042 Abstraction limited to 15,000 m^3/day. Reduce abstraction to 13,000 m^3/day when river is at or below minimum flow.	Allocation insufficient to meet projected growth within the consent term (refer Section 3.4 below). Leakage standard in consent not met. Leakage condition set based on historic pressure settings of network. Unlikely to be achievable with lower network pressures as per pressure management system. Ongoing resourcing commitment required to maintain leakage within target levels. Subject to review in 2022 and 2032.
Existing Intake	Infiltration gallery ~900 m long, parallel to the river.	- Concerns re structural resilience/vulnerable to interruption. - Capacity limited to existing peak demand – may not be able to exercise full consented allocation. - Requires regular scarification (riverbed disturbance).
Water Quality	Treatment plant capacity (15,000 m^3/day) matches water allocation. Treated water meets NZDWS	Treatment capacity is insufficient to meet growth demands (refer section 3.3 for growth projection). Single water source so may be vulnerable to any changes in source water supply quantity or quality. Vulnerable to high-flow turbid water in river. New NZDWS and Quality Assurance Rules may affect compliance status.
Resilience	Treated water storage equivalent to approx. 1-day supply	No alternative water source in case of an emergency (eg earthquake). No long-term storage in event of severe drought or interruptions to supply.
	Vulnerability to high flow / high turbid conditions	No alternative source when river water turbidity is high and treatment plant production rates impacted as a result of high turbidity source water.
	Effects of climate change	Vulnerability of supply due to effects of climate change is unknown. Increased extremes may result in more frequent low flow events (restrictions in abstraction) and more frequent flood / high turbidity events.

The existing consent was determined when the district's projected growth was 0.04-0.4% per annum. Recent growth has significantly exceeded these rates and projected growth rates for the next 50 years are 2-3% per annum for the 95th percentile projections. Council has adopted the 95th percentile projections for infrastructure planning purposes.

The existing consented allocation was sufficient to meet the projected 50-year demand at the time that consent was granted, however, it is insufficient to meet the projections based on the increased growth rates that have been, and are projected to be, experienced. If storage or an additional water source is not added to the system, the scheme may not be able to meet projected Summer peak demand as early as 2025 – 2030, depending on

effectiveness of network and demand management measures**.** Even if storage is added, the existing consent is insufficient to meet projected demands beyond 2034-2039.

The following matters must be addressed to achieve a secure, resilient and statutorily compliant water supply system:

- Improvements to the scheme are required to give effect to Te Mana o te Wai. This requires engaging with iwi and hapū to determine how Te Mana o te Wai is given effect in the context of the Levin water supply, and how the relationship between Council and iwi and hapū will be fostered, recognising the principles of Te Mana o te Wai. Further, it is expected that giving effect to Te Mana o te Wai will require a reduction (if not a cessation) in the amount of water abstracted under minimum flow conditions. This would require an alternative water source, bulk storage and / or water use reductions and restrictions to be implemented.
- Projected growth is significantly greater than anticipated at the time that the Levin water supply consent was obtained. Without an alternate water source or bulk storage, summer demand could exceed consented supply as early as 2025 - 2030. If bulk storage is available, the existing consent is likely to provide sufficient water to about 2039, beyond which an additional water source will still be required.
- Assuming a 50-year planning timeframe, the existing consent has a shortfall of supply of 7.8 - 10 million m^3/year.
- Irrespective of the supply option adopted, it is critical that Council continues to implement network improvement measures and pressure management to maintain the system within the Council's target of Band B Infrastructure Leakage Index or better. This is also required to meet Regional Policy Statement policy definitions as to what is considered reasonable and justifiable water demand for a public water supply.
- An alternate water source and / or off-river storage is required to improve the resilience of the supply against drought conditions and high-flow, high-turbidity conditions in the Ōhau River. To provide an effective drought response for a 50-year planning timeframe, storage in excess of 500,000 m^3 is required, and / or an alternate water source not susceptible to the same drought conditions as the Ōhau River is required.
- Post-emergency supply provisions have been assessed as follows:
  - Immediate response period of 7-days, supplying 20 L/person/day. The current treated water storage is unlikely to meet this requirement as early as 2031. A total of 10-12,000 m^3 effective storage is recommended to meet this level of service at the 50-year timeframe.
  - Bulk storage to provide up to 30 days supply at average demand. To meet this requirement 480,000 m^3 of storage will be required in 2042 and 1,000,000 m^3 will be required in 2072.

A qualitative multi-criteria assessment of options was undertaken. Each option was assessed in terms of the availability of water, impact on cultural values, supply resilience, environmental effects, source water suitability, and capital and operating costs. The options identified and the multi-criteria assessment are summarised in the following diagram. In this assessment, all criteria have been given the same weighting. The highest score is considered the preferred option.

	Availability of Water	Cultural Values	Supply Resilience	Environmental Considerations	Source Water Suitability	Economics: Capital and operating costs	Score	Ranking
Bulk Raw Water Storage Using Existing Consented Allocation							22	3
Ohau River Water Harvesting (Reservoir) + Supplementary Allocation							28	1
Other Surface Water Resource: Waikawa Stream							16	5
Other Surface Water Resource: Upper Mangahao							14	8
Other Surface Water Resource: Tokomaru River							14	8
Other Surface Water Resource: Manawatu River							14	8
Groundwater Bores							14	8
Rainwater Harvesting							24	2
Wastewater Treatment & Re-use: Potable Reuse							14	8
Wastewater Treatment & Re-use: Bulk non-potable							16	5
Wastewater Treatment & Re-use: Reticulated non-potable							14	8
Seawater Desalination							16	5

The assessment shows that:

- The preferred option is a Bulk Raw Water Storage Reservoir and additional water allocation provided via water harvesting from the Ōhau River.
- The second and third ranked options are individual household rainwater harvesting and a Bulk Raw Water Storage Reservoir by itself. Rainwater harvesting is already being implemented and, while ranked highly, is scored "red" on the ability to meet the future water demands. It therefore can be considered as only part of the overall solution at best. The Bulk Storage Reservoir by itself being ranked third confirms the criticality of this element of the preferred option.

A constraint mapping exercise has been undertaken to identify suitable sites for the recommended reservoir. The constraint mapping looked for sites which were upstream of the existing intake (to obtain the same or better source water quality and achieve efficient conveyance to the water treatment plant), size of property required for the reservoir. The assessment sought to avoid sensitive areas such as river corridor, national grid transmission lines, fault lines and outstanding natural features and landscapes. Three potential properties were identified and a site has been purchased on a willing-seller, willing-buyer basis.

The recommended approach to implement the preferred option and to ensure a secure and reliable water supply for Levin, is summarised in the following diagram.

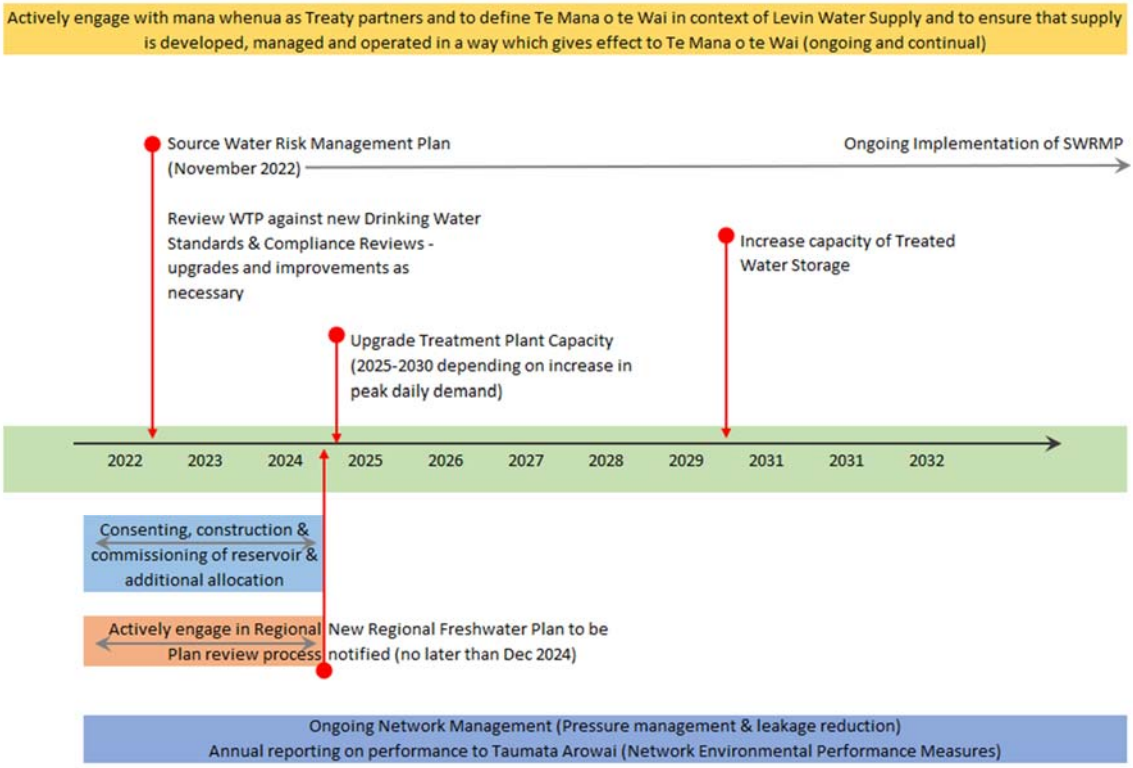


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Appendix A Median Growth Water Demand Projections
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Appendix C Ōhau River Supplementary Water Assessment
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1 INTRODUCTION

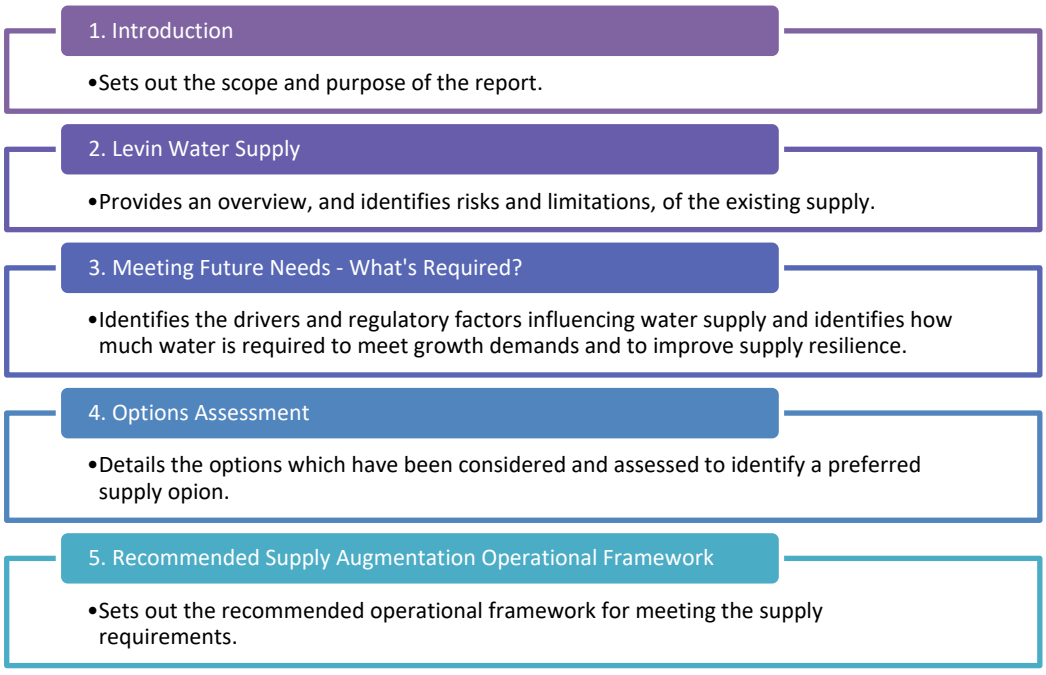
This Water Supply Augmentation Operational Framework has been developed to assess options and identify a recommended pathway for securing sufficient drinking water to meet Levin's reasonable needs for the foreseeable future and to improve the security and resilience of the supply.

In the context of this report, "drinking water" is the water which is supplied to Council's Levin water supply network. This network provides a range of potable and non-potable uses (e.g., outdoor discretionary use) as well as residential, commercial, industrial, and community uses. The water is delivered via a reticulation network and it is not possible, with the existing infrastructure, to separate potable and non-potable water uses[1]. Therefore, all water delivered via the network is required to be treated to drinking water standards.

The Levin water supply currently sources its water direct from the Ōhau River, with treatment to meet the New Zealand Drinking Water Standards. While there is sufficient water available to meet current needs, the community is experiencing significant growth, and this is expected to continue for at least the medium term. Existing resource consents for the scheme do not provide sufficient allocation to meet projected growth needs. Further, the system is vulnerable to flood events which result in highly turbid source water. For example, in June 2021, supply to the township was interrupted for approximately three days when the river was in flood and the treatment plant was unable to produce drinking water in sufficient quantity to maintain supply. Further, there is insufficient storage and no alternative water source to meet the community's need if supply is interrupted e.g., in a large seismic event.

This report assesses water requirements to meet growth demands and to improve the resilience of the supply. It adopts a 50-year planning timeframe when considering options. It considers alternative water sources to identify a preferred option and recommended framework for meeting supply needs. It is focused on source water supply only. Treatment and reticulation / network management components of the scheme are outside of the scope of this document. The Council has initiated a master planning project which will address how the reticulation network will be expanded, upgraded and managed to meet current and future needs.

The structure of this document is as follows:



[1] *A separate reticulation network for non-potable use is one of the options which is considered in section 4 of this report.*

2 LEVIN'S DRINKING WATER SUPPLY

Levin's drinking water is currently sourced from the Ōhau River approximately five kilometres south-east of Levin centre. The reticulation network provides water to domestic, community, commercial and industrial uses and delivers water for both potable and non-potable uses. However, as the water is supplied via a single reticulation network, all water is required to meet drinking water standards.

The Ōhau River is a significant water body within the Horowhenua District and is of cultural significance to tangata whenua, iwi and hapū. The Ōhau River is "*a taonga of central, material and spiritual significance to Ngāti Tūkorehe, Ngāti Kikopiri, Ngāti Raukawa ki to Tonga and Muaūpoko*" and has been identified as a "*source of spiritual sustenance, mahinga kai and swimming and camping*"[2]. The Ōhau Catchment is a "*source of enrichment of Muaūpoko extending back to Whatonga, the father of Toa, who is the eponymous ancestor for Muaūpoko*"[3].

The Levin water supply has a resource consent to abstract water from the Ōhau River via an infiltration gallery. The consent enables the council to take up to 15,000 m^3/day under normal conditions. When the river is below its minimum flow defined in the Regional Council's One Plan (0.820 m^3/s), the Council is required to reduce its abstraction to 13,000 m^3/day. Further, an additional 750 m^3/day may be taken for non-consumptive purposes within the treatment process. This additional non-consumptive take must be returned to the river within 400 m of the abstraction point.

Water is treated to NZ Drinking Water Standards via a Water Treatment Plant (WTP) at the same site. The treatment process consists of clarification, UV disinfection and chlorine dosing.

There is 12,000 m^3 of post-treatment water storage at the WTP site. This storage comprises a 6,000 m^3 steel tank installed in 2017 and two older concrete tanks with a combined capacity of 6,000 m^3. These storage tanks provide only approximately 1.25 days storage at current average demand and therefore their functionality is limited to assisting to meet short-term (ie diurnal variations) peak demand and providing firefighting capacity. The tanks do not provide sufficient storage to cater for growth or to meet any extended interruptions to the supply. Further, it is expected that the available storage would decrease to approximately 6,000 m^3 in the event of a major earthquake given the age of the older tanks and their likely susceptibility to cracking in a major seismic event[4].

Treated water is delivered to the Levin urban water reticulation network which services approximately 20,000 people across 8,500 properties throughout Levin and parts of Ōhau and Hokio Beach.

The Council is required to manage the supply in accordance with a Water Demand Management Plan that is reviewed no less frequently than every three years.

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[2] *Cultural Impact Assessment on behalf of Te Iwi o Ngāti Tūkorehe Trust, submitted as part of the consent application for the existing Levin Water Supply consent, 2014.*

[3] *Cultural Impact Assessment on behalf of Muaūpoko Tribal Authority, submitted as part of the consent application for the existing Levin Water Supply consent, 2014.*

[4] *Blue Drop Engineering, 2022 notes that earthquake resilience reports on the concrete tanks commissioned following the 2011 Christchurch earthquakes found that the concrete tanks would likely not be subject to a calamitous failure of the structure in a major earthquake, but side wall cracking could be expected and their capacity to provide for post-earthquake demand would therefore be limited. The reports found that it would be uneconomical to strengthen the concrete tanks.*



Figure 2.1: Location Overview

2.1.1 Current Water Use

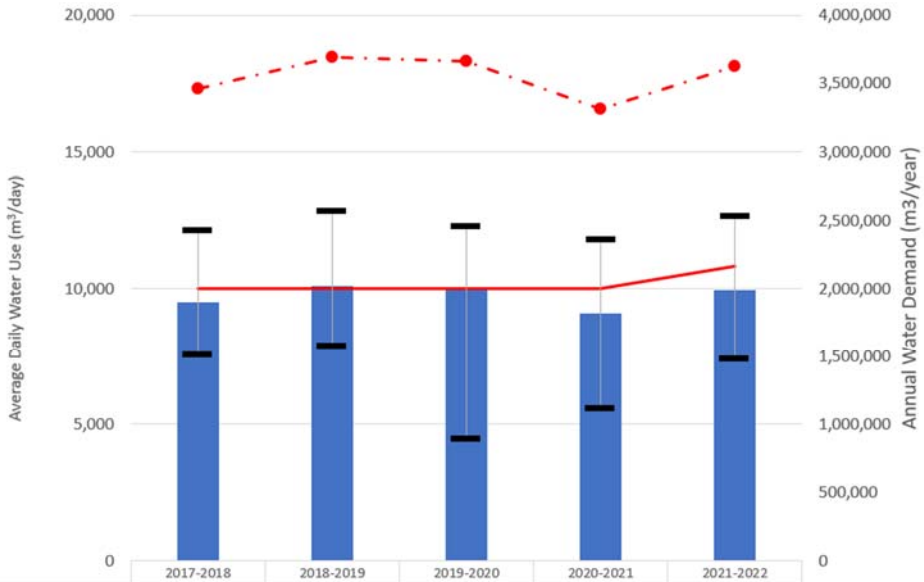
Current water use is shown in Figure 2.2. This data is sourced from the water meter on the supply main 'downstream' of the treatment plant and treated water storage reservoir. It therefore reflects community demand.

Abstraction figures for the same period indicate that, on average, there is approximately 1,000 m^3/day more abstracted from the river than delivered to the community. The additional water abstracted is for non-consumptive uses in the treatment process and is discharged back to the river[5].

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[5] *The resource consent provides for 750 m^3/day above the 15,000 m^3/day limit to be abstracted for non-consumptive use. It does not restrict more than 750 m^3/day being abstracted for non-consumptive use subject to the total amount of abstraction not exceeding 15,000 m^3/day. (That is, the fact that more than 750 m^3/day has been abstracted for treatment plant and non-consumptive uses does not constitute a non-compliance with the consent as the total abstraction has not gone above the 15,000 m^3/day limit and therefore the additional 750 m^3/day abstraction condition has not needed to be exercised).*

The discharge of return water is authorised under a separate consent which authorises up to 1,000 m^3/day of non-consumptive water and stormwater. Return discharges in excess of 1,000 m^3/day are a non-compliance with the consent limit. Note that this report has not assessed the amount of water actually returned to the river, as some of the water abstracted but not delivered to the reticulation network may also be used elsewhere in the system. The scope of the return water and its compliance or otherwise is outside of the scope of this report.



	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022
Average Water Demand (m3/day)	9,490	10,112	9,997	9,078	9,940
Minimum (m3/day)	7,561	7,876	4,440	5,563	7,404
Maximum (m3/day)	12,143	12,858	12,307	11,811	12,674
Policy 5-12 Assessment (m3/day)	10,005	10,005	10,005	10,005	10,833
Annual Water Use (m3/yr)	3,463,716	3,690,890	3,658,863	3,313,322	3,627,933

Figure 2.2: Current Levin Water Demand

Figure 2.2 shows that there was a reduction in water use in the 2020-2021 year. This is a result of leak detection and repair, and pressure management initiatives implemented by Council. However, it is noted that these reductions were not fully sustained leading into the 2021-2022 water year.

The reason the previous reductions were not sustained into the 2021 - 2022 water year was because of the internal focus coming off the pressure management of the network. Council has subsequently added additional resource and capability to ensure focus and effort on pressure management of the network is maintained. This is expected to result in an improvement for the 2022/2023 year and beyond.

Within the Horizons region, the Regional Policy Statement (RPS) includes Policy 5-12 which requires that the amount of water taken by users is *"reasonable and justifiable for intended use"*. Policy 5-12(d) provides a basis for determining what would be "generally considered" reasonable for a public water supply, which is:

"(i) an allocation of 300 litres per person per day for domestic needs, plus

(ii) an allocation for commercial use equal to 20% of the total allocation for domestic needs, plus

(iii) an allocation for industrial use calculated, where possible, in accordance with best management practices for water efficiency for that particular industry, plus

(iv) an allocation necessary for hospitals, other facilities providing medical treatment, marae, schools or other education facilities, New Zealand Defence Force facilities or correction facilities, plus

(v) an allocation necessary for public amenity and recreational facilities such as gardens, parks, sports fields and swimming pools, plus

(vi) an allocation necessary to cater for the reasonable needs of animals or agricultural uses that are supplied by the public water supply system, plus

(vii) an allocation necessary to cater for growth, where urban growth of the municipality is provided for in an operative district plan for the area and is reasonably forecast, plus

(viii) an allocation for leakage equal to 15% of the total of (i) to (vii) above."

Figure 2.2 compares Levin's actual water use to what is determined 'reasonable' under RPS Policy 5-12. The Policy 5-12 assessment in Figure 2.2 uses a connected population of 22,000 persons (as per the Taumata Arowai Register of Drinking Water Supplies, May 2022), a total of 1,500 m^3/day for industrial use[6] and no allowance for factors provided for under items iv, v, vi, or vii of Policy 5-12(d). It therefore is a conservatively low estimate of what would be considered reasonable for the Levin water supply if Policy 5-12 were to be applied. Figure 2.2 shows that current water use is below this conservatively low estimate under Policy 5-12. Therefore, the community's water demand can be considered reasonable as defined by Policy 5-12 of the One Plan.

While the water demand is below that considered reasonable under Policy 5-12 of the One Plan, this does not mean that water can be used indiscriminately or that efforts to ensure efficient use and to reduce leakage can be lifted. The sustainable management purpose and Section 7b of the RMA; the National Policy Statement on Freshwater Management requirement to give effect to Te Mana o te Wai; and the Regional Policy Statement all require water to be used efficiently and in a way which avoids effects on the environment and gives first priority to the health and well-being of the river. This is irrespective of whether the above 'reasonableness' benchmark is met. In addition, ongoing and further efficiency improvements impact positively on the cost of supply, resilience and sustainably of the supply system.

2.2 Resource Consent to Abstract Water from the Ōhau River

The abstraction from the Ōhau River is authorised by resource consent ATH-1991006011.03. This allows the District Council to take up to 15,000 m^3/day for the Levin water supply. The resource consent expires in July 2042. The following summarises the key consent requirements, including how the supply is required to be managed under the existing consent to minimise potential effects on the river. In addition to the requirements summarised below, the consent also requires backflow prevention devices, metering and telemetry reporting of water abstracted, and that the Council establish a Levin Water Working Group comprised of submitters to the consent application.

2.2.1 Restrictions at Times of Low Flow

When the river is below its minimum flow (0.820 m^3/s as measured at the Rongomatane gauging site immediately upstream of the intake and as defined in the Regional Plan), the Council must reduce its take to no more than 13,000 m^3/day and must also apply water restrictions as set out in the Water Demand Management Plan. (Section 2.5.1 discusses the frequency and timing of when the river is expected to be below minimum flow).

The consent requires that the Council manage the supply in accordance with the four trigger levels set out in Table 2.1. These trigger levels can be amended via changes to the Water Demand Management Plan, and without a s127 variation to the resource consent subject to the amended triggers being set at the same or higher river flow level to that specified the consent.

The consent specifies trigger levels based on the river flow only (Table 2.1). The Water Demand Management Plan defines the trigger levels as a combination of river flow and water demand (refer Table 2.1). The actions relating to each trigger level are defined only within the Water Demand Management Plan, except that the consent requires the water abstraction to be reduced to 13,000 m^3/day at Trigger Level 4.

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[6] *This equates to the 80th percentile of daily trade waste volumes from the Alliance Meats site, being the largest connected water user. As it represents only one industrial user, this is a conservative (low) estimate of all industrial uses in the community that may be considered under Policy 5-12(d)(iii). A conservative estimate has been adopted to avoid over-estimation of the Policy 5-12 assessment for the purposes of this document only and in order to confirm that the current use falls within the Policy 5-12 assessment. That is, if current use is within a low estimate of Policy 5-12 reasonable use calculation, there is a high degree of confidence that the water use is considered reasonable and efficient under the One Plan policies.*

Table 2.1: Summary of Consent Triggers Levels

Trigger Level	River Flow Trigger (m^3/s)	Trigger Level Conditions in Demand Management Plan	Restrictions Applied (as per Demand Management Plan)	Maximum abstraction
n/a	> 2.5	River Flow >2.5 m^3/s Demand < 9,500 m^3/day	None - no restrictions	15,000 m^3/day
1	1.5-2.5	River Flow 1.5-2.5 m^3/s Demand > 10,000 m^3/day	Time of use restrictions on garden irrigation; handheld irrigation allowed.	
2	1.0-1.5	River Flow 1.0-1.5 m^3/s Demand >11,000 m^3/day	Increased restrictions on outdoor use, including no hosing of paved areas. Public spaces not to be irrigated from Levin water supply. House washing restricted to bucket supply only.	
3	0.82-1.0	River Flow 0.82-1.0 m^3/s Demand > 12,000 m^3/day	Increased restrictions on outdoor use including alternate day hand held hosing restrictions. Filling of pools restricted.	
4	<0.82	River Flow < 0.82 m^3/s	No outdoor use. Fountains not to operate. Restrictions on commercial outdoor use unless expressly approved by Council.	13,000 m^3/day

In addition to the above abstraction limits (which relate to the amount of water that can be used to supply water to Levin), an additional 750 m^3/day may be taken subject to it being discharged to the Ōhau River within 400 m of the point of take. This water take is non-consumptive and the water is used to provide water for backwash for the intake and treatment process. As it is a non-consumptive allowance, and is not used for community supply, it is not considered further in this report.

2.2.2 Target Leakage Reduction

The resource consent requires that the system be managed to ensure that leakage is less than 284 litres/connection/day. This target was required to have been achieved by June 2020 and to thereafter be achieved throughout the term of the consent.

In considering network efficiency and leakage, the Infrastructure Leakage Index or ILI is a key measure that enables benchmarking across supplies (Figure 2.3). As defined in Taumata Arowai's[7] 'Drinking Water Network, Environmental Performance Measures and Guidance Material' document:

> *"Infrastructure Leakage Index (ILI) is the non-dimensional ratio of Current Annual Real Losses (CARL) to Unavoidable Annual Real Losses (UARL). The ILI measures how effectively infrastructure activities (speed and quality of repairs, active leakage control and pipe materials management) are being managed at current operating pressure."*

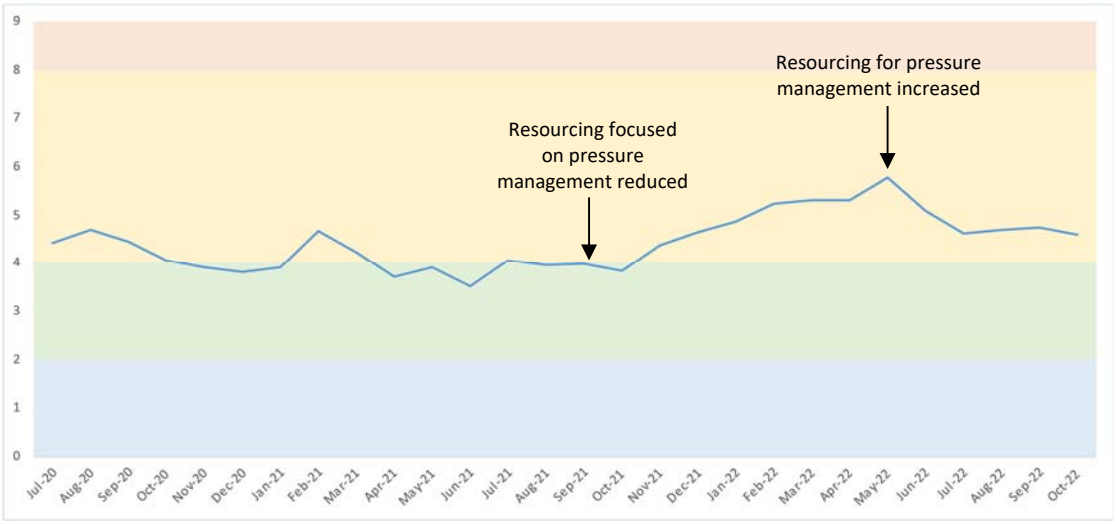
In addition to the leakage target in the consent, Council has adopted, in its Long Term Plan, a performance target of ILI in Band B (being an ILI of between 2 and 4).

Council actively monitors and assesses the leakage per connection (based on measured minimum night flows, with an allowance for actual night-time usage) and ILI on a monthly basis (Figure 2.3). From the 2022-2023 water year, Council will be required to report this information to Taumata Arowai in accordance with the Network Environmental Performance Measures under Section 146 of the Water Services Act.

The leakage target set in the consent (284 l/connection/day) was derived from an ILI of 3.0. Since that time, Council has implemented a programme of active pressure management across the network and the system now operates at an overall lower pressure. The methodology for determining ILI, which is considered a more appropriate benchmark for assessing network performance, depends on network pressures. The leakage target in the consent of 284 l/connection/day now requires an ILI of 2.73. Figure 2.3 shows the ILI for the system since July 2020.

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[7] *Taumata Arowai is the drinking water services regulator for Aotearoa.*



ILI range	BAND	General description of Real Loss Management Performance Categories for Developed and Developing Countries
Less than 2	A	Further loss reduction may be uneconomic unless there are shortages; careful analysis needed to identify cost-effective improvement
2 to < 4	B	Potential for marked improvements; consider pressure management, better active leakage control practices, and better network maintenance
4 to < 8	C	Poor leakage record; tolerable only if water is plentiful and cheap; even then, analyze level and nature of leakage and intensify leakage reduction efforts
8 or more	D	Very inefficient use of resources; leakage reduction programs imperative and high priority

Figure 2.3: Network Performance (ILI) for 2021 – 2021 Water Year

The current performance of the system meets the Council's Long Term Plan target of Band B for ILI. However, it does not meet the target per connection leakage rate stated in the consent, nor the ILI of 3.0 from which that leakage rate is derived.

The Council's leakage report for the period ending June 2021, highlights the following actions to manage leakage rates:

- *"Continued monitoring of DMA flows in order to maintain efficient maintenance responses and reduction of leaks*
- *Further leak detection surveys in areas of concern identified by DMA monitoring*
- *Further optimisation of PRV controls including changes to the pressure management zones if required*
- *An Advanced Meter Reading trial is currently in progress which uses smart meters that has built in leak alarming and flow logging capability. The result of this trial will determine if the extent of private side leakage is worse than anticipated. Without universal metering, private side leakage affects Night Flow calculations and Water Balance estimates.*
- *The criteria used for pipeline renewal selection will place more emphasis on leakage in the relevant area, now that permanent DMA flow monitoring is being performed.*
- *Consumer awareness campaigns to gather more momentum with fixing private leaks."*

For the purposes of this report, and the water demand projections presented in section 3.4, two baseline data points are assumed:

- The 2020/2021 water year represents a baseline assuming that active network management and leakage detection and repair is occurring at the upper end of expected levels. This was a water year where the Council's target of Band B for ILI was achieved for 6 out of 12 months.
- The 2018/2019 water year represents a baseline assuming active network management and leakage detection and repair was not occurring at expected levels. This was a water year where the Council's target of Band B for ILI was not achieved, as it was prior to implementing the pressure management system.

It should be noted that the 2018/2019 baseline and subsequent projections are presented only to indicate the impacts of not maintaining good network and leakage management. Active network and leakage management to water industry standards is critical and must be maintained on an ongoing basis. Further, from the 2022/2023 water year there will be regulatory oversight of the network performance via the reporting of ILI and other performance measures to Taumata Arowai.

2.2.3 Review Clauses

The consent includes a requirement (condition 17) for a review of the Levin Water Supply to be undertaken in 2022 and 2032. The review is to consider water use, future projections, effectiveness of demand management measures, and present an assessment of alternatives. A summary of the assessment of alternatives, based on the options presented in this document, was included in the Levin Water Supply Condition 17 Report submitted to the Regional Council at the end of March 2022. This review report is used by the Regional Council to inform its decision as to whether to initiate a review of the consent. Any such review could be initiated in either July 2022 or July 2032. A review was not initiated in July 2022.

2.3 Existing Infiltration Gallery

The existing infiltration gallery, located in the bed of the Ōhau River adjacent to the WTP, was constructed in 1993. It comprises two arms orientated parallel to the bed of the river. The intake is a 750 mm diameter Aluflo slotted pipe. The upstream arm is 175 m long and the downstream arm is 66 m long. Both arms connect to a common wellhead from which water is abstracted and pumped to the treatment plant.

It is understood (pers comms, HDC Operations, November 2022), that the existing intake may be limited physically and this may not allow the abstraction of the full consented volume of water (i.e., 15,000 m^3/day)[8].

Further, HDC Operators have expressed concern regarding the structural resilience of the intake chamber. Current operations also require regular scarification of the riverbed to improve infiltration and percolation of water (as provided for by resource consent ATH-2008010962.02).

2.4 Water Treatment

The Water Treatment Plant was upgraded in 2017 to achieve compliance with the NZ Drinking Water Standards, specifically to provide treatment for giardia and cryptosporidium. The treatment plant is now fully compliant with the bacteria and protozoa compliance criteria of the previous NZ Drinking Water Standards[9]. It is noted that the Drinking Water Standards have been reviewed and the new standards came into effect on 14 November 2022. This includes new Quality Assurance Rules for suppliers to demonstrate compliance with the standards. A review of the system's compliance against the updated Drinking Water Standards and quality assurance rules is being undertaken.

High Turbidity Occurrences

High flows in the Ōhau River can lead to high turbidity in the source water which impacts treatment plant production rates. In June 2021, elevated turbidity in the source water resulted in the treatment plant not being able to produce compliant water in sufficient quantities to maintain supply to the network. This resulted in treated water reservoir levels being depleted and supply to the community being interrupted. Some industries and businesses were required to cease operation because of the shortage of water supply. Tanker water was made available for residential users in some places. Following heavy rain on 27 June 2021, Council issued a notice (28 June 2021) requesting all residents to "reduce or stop using water immediately". The notice stated that *"Due to the most recent rainfall*

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[8] *Since consent was granted in 2017 peak daily abstraction has been in the order of 13,500 m^3/day, and minimum abstraction during winter has been in the order of 8,000 m^3/day.*

[9] *As at 30 June 2021 and as reported in HDC's Annual Report 2020/2021.*

event, the water treatment plant [is] struggling to effectively treat the muddy river water for our drinking water supplies. The community demand e.g. residents and businesses connected to the town water supplies are exceeding what the treatment plant can deliver. There is a real risk that the water supply will run-out and the community will need to rely on bottled water or water tank supplies to service their minimum requirements.[10]" It stated that residents could expect this situation to continue for at least 48 hours. Water tankers were deployed throughout the community to provide drinking water.

Council staff[11] stated that turbidity levels in the river were five times the level required for the treatment plant to meet the drinking water standards.

While this is an infrequent situation, it is one which creates significant disruption to the community including significant impacts on social and economic wellbeing. This is discussed further in section 2.5.1.

2.5 Ōhau River

Levin's water supply is currently sourced solely from the Ōhau River, as described above. The following provides a discussion of the flow regime in the Ōhau River from an assessment undertaken by Keane & Associates Ltd.[12] Flow statistics for the Ōhau River at Rongomatane, based on flow gauging and monitoring over the period July 1979 to June 2021, are given in Table 2.2.

Table 2.2: Ōhau River at Rongomatane Flow Statistics, July 1979 to June 2021

	River flow at Rongomatane (m^3/s)
Minimum Flow (as per the One Plan – this is the regulatory flow set at which all but essential takes are required to cease abstraction)	0.820
Mean Annual 7-day Low Flow (MALF)	1.174
Median	3.809
Mean	6.460
3 x median Used as an index to indicate biological disturbance (flushing flows)	11.430
5 x median Adopted as an interim threshold at which water is likely to be too turbid for effective drinking water treatment	19.045

2.5.1 Frequency and Duration of Minimum Flow Constraints

Horizons Regional Council's One Plan (Regional Policy Statement and Regional Plan) sets a minimum flow of 0.820 m^3/s for the Ōhau River at Rongomatane (as a mean daily flow). This is the flow below which all abstractions other than essential takes are required to cease. Public water supply is defined to be an essential water take in the Regional Policy Statement and may continue to abstract, however, a reduction in abstraction is required; from 15,000 to 13,000 m^3/day.

From the flow record available, the frequency and duration of minimum flow occurring in the Ōhau River at Rongomatane is as follows:

- The river has entered minimum flow conditions on 6 years since 1979 ie on average, 1 in every 14 years.
- The maximum number of days per year that the river is below minimum flow is 50 days. This occurred in the 2003/2004 summer.

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[10] *HDC news published on HDC website, 28 June 2021.*

[11] *Stuff article, 7 July 2021, "Investigation into alternative water source from Horowhenua".*

[12] *Keane Associates Limited, letter dated 24 November 2021 to Damwatch Limited, Ref P21X.*

- The maximum consecutive number of days that the river is below minimum flow is 25 days. This also occurred in the 2003/2004 summer. In the other five years, the maximum consecutive number of days that the river was below minimum flow was less than 10 days.
- When the river has fallen below minimum flow, this has always been in January to May. The river has not fallen below minimum flow in June to December.
- The months that have most frequently experienced minimum flow conditions are March and April (that is, minimum flow is more likely to occur in late summer/early autumn). For the flow record available (1979 – 2021), the total number of days when the river was below minimum flow was:
  - January: 13 days
  - February: 18 days
  - March: 38 days
  - April: 29 days
  - May: 10 days
  - July - December: 0 days

Table 2.3 summarises the expected duration of consecutive days below minimum flow for various return period events[13].

Table 2.3: Estimated Consecutive Days Ōhau River is Below Minimum Low

Return Period (Average Recurrence Interval, ARI) (Years)	Consecutive Days
5	0
10	2
20	6
50	16
100	26
200	37
500	53
1000	66

Therefore, if the water supply was to be limited such that no abstraction was allowed below minimum flow, then supply could be expected to be interrupted, on average, once every 14-years. Interruption of supply could occur for up to 26 days in a row (estimated at a 100 year return period event). The most likely time of the year for minimum flow conditions to occur is mid-late summer and early autumn.

2.5.2 Frequency and Duration of High Turbidity Constraints

One of the limitations of the existing system, shown by experience, is that supply can be interrupted by high turbidity events in the river. Supply was interrupted in 2021 for approximately three days because of highly turbid water in the Ōhau River. HDC has advised that operation of the Levin Water Treatment Plant is constrained when raw water turbidity reaches 10 NTU. The treatment plant is shut down when turbidity reaches 20 NTU.

Keane Associates Ltd found a very poor relationship between turbidity and flow, and noted considerable variability in the events which cause high turbidity. This is not unexpected given variability in rainfall patterns (intensity, duration and location) and a wide range of other processes that affect sediment erosion and entrainment leading to elevated turbidity in the river.

[13] *Assuming a Pearson Type 3 statistical distribution.*

Keane Associates Ltd found[14] (emphasis added):

> *"Raw water turbidity is measured at the WTP on the raw water delivery pipeline. There is a poor correlation between raw water NTU data and river flow, including when turbidity data is lagged by 1 hour for flow travel time. When compared with flow hydrographs* ***the magnitude and timing of turbidity is highly variable from one flood event to the next, so flow alone is not a consistent predictor of turbidity.*** *Some events have high turbidity and others not.* ***During the period 1/7/2017 to 1/7/2021 the river appears to have been turbid at greater than 20NTU for less than 0.5% of the time.***
>
> *Another approach is to relate turbidity to SSC and flow. The relationship between SSC and turbidity (NTU) depends on the refractive qualities of the local sediment and is determined empirically using concurrent measurements. Preliminary analysis of the suspended sediment grab sample data and the NTU data (9/1/2018 to 1/12/2020) shows that while there is overlap between the two datasets, this correlation is also poor with a high level of uncertainty."*

Since the existing consent was granted, and data has been recorded within Council's Infrastructure Data system, the river has had a turbidity above 10 NTU turbidity approximately thirteen times, with it reaching above 20 NTU approximately 9 times.

In general, these events haven't impacted supply, however in late June 2021 high turbidity did affect the ability of the WTP to process sufficient Drinking Water Standard compliant water to meet community demand. On 28 June 2021, Horowhenua District Council issued public notices across a range of media, including press releases and social media, requesting the community conserve water as reservoir levels dropped to what was described as "critical levels". Some businesses and industries were requested to shut down operations. In response to this request, Daily Total Demand (m^3/day) delivered to Levin was immediately reduced to levels similar to what is typically experienced as 'Sunday Demand' (06 June, 13 June, 20 June and 27 June – refer figures in Appendix D). Water Treatment Plant efficiency dropped to approximately 54% compared to normal efficiency rates of 90-95%. Water demand from Levin was kept low for a period of 3 days, 28-30 June 2021. On 1 July the water supply service returned to normal. More details of this event are provided in Appendix D.

In the absence of any alternative relationship at this time, Keane Associates Ltd note that a flow exceeding five times the median (5x median) could be used to indicate potentially high turbidity. This is because, at this flow the gravel bed of the river is likely to be fluid and flood flows turbulent enough to entrain sediment.

A flow of five times median flow is expected to occur approximately 5% of the time. This is a conservative estimate of the likely limitations of abstraction since turbidity greater than 20 NTU has been experienced only approximately 0.5% of the time recently (2017 – 2021). 20 NTU is the turbidity level at which the WTP shuts down the abstraction. While the treatment plant can produce drinking water standard compliant water from raw water with turbidity up to 20 NTU, the production rates decrease once turbidity exceeds 10 NTU.

The five times median flow threshold has therefore been adopted as a conservative interim threshold for determining when abstraction may be constrained due to high turbidity. A monitoring programme has been initiated (October 2022) to better understand the relationship between turbidity and flow.

2.5.3 Impacts of Climate Change on River Flows

There is potential for the flow regime of the Ōhau River to change from that experienced historically as a result of effects of climate change. Horizons Regional Council has commissioned a "Regional Climate Change Risk Assessment"[15]. This assessment found that:

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[14] *Keane Associates Ltd, 24 November 2021, letter to Damwatch Engineer.*

[15] *Tonkin + Taylor Ltd, September 2021, Manawatū-Whanganui Regional Climate Change Risk Assessment.*

"Precipitation changes have seasonality and spatial variations throughout the region, particularly when looking out to the end of the century. Precipitation is projected to on average decrease on the eastern side of the Ruahine and Tararua ranges in the spring and winter months by mid-century, whilst there is a north- south divide present in summer precipitation changes. Northern areas of the region are projected to experience a 5% increase in summer precipitation, whilst southern areas are projected to have a 5% decrease. Winter rainfall by the end of the century is projected to increase by 20% in the north west of the region, and decrease by 20% in the south east of the region. The north-south divide is no longer present in summer months at the long-term timeframe, and spring rainfall is projected to increase by 5% across majority of the region (NIWA, 2016). Increases in precipitation can lead to the increased frequency and intensity of inland flooding and landslide events. Due to the geography (e.g. vast river networks) and geology (e.g. erodible soils) of the region increased precipitation is likely to exacerbate the impacts from these climate-induced hazard events."

Projections for the Ōhau River, being in the south-west of the region remain unclear. It is most likely that any changes in flow in the Ōhau River, particularly over the short term, will be within the natural variation already experienced. This is because the flow regime is controlled by the weather systems and orographic effect of the Tararua Ranges. The climate risks to the District have been identified in the regional assessment as shown in Figure 2.4. This identifies risks to water supplies given the District's dependence on surface water takes.

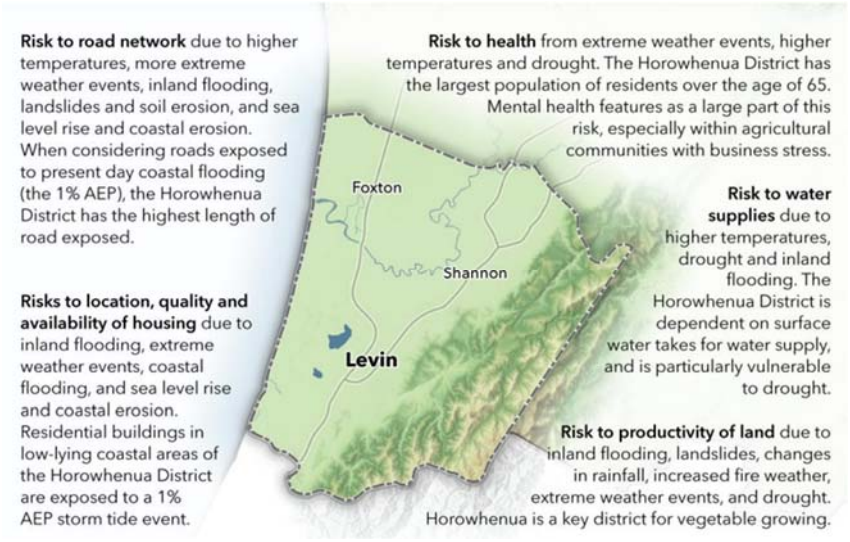


Figure 2.4: Overview of Risks for Horowhenua District
Source: T+T, September 2021, Manawatū-Whanganui Regional Climate Change Risk Assessment

In terms of risks to water supply, the regional risk assessment is shown in Figure 2.5. It also notes that:

"Adaptive capacity of water supply sources within the region will rely on the maintenance/enhancement of storage and the ability to manage water demand levels - particularly in areas such as Palmerston North, Ohakune, Feilding and Levin where development and growth is occurring. Targeted interventions such as demand management and behaviour changes could improve water efficiency within the region."

Hazard	Present	2050	2100	Commentary
Drought	High	High	Extreme	Increased exposure of water supply sources with time, with Tararua district liekly to be the most affected. Sensitivities include reduced flows, over allocation, and reduced water availability and quality. Water restrictions and metering can help reduce the impacts of drought.
Higher temperatures	Low	Moderate	High	sources with time, with Tararua district liekly to be the most affected. Sensitivities include reduced flows, over allocation, and reduced water availability and quality. Water restrictions and metering can help reduce the impacts of drought.
Inland flooding	Low	Moderate	High	Increased exposure on the Manawatū Plains (including Manawatū, Rangitīkei and Whanganui). Flood waters can overwhelm groundwater wells and cause rivers to swell, leading to contamination. Legislation is in place to improve water quality within the region through One Plan and Water Matters.

Figure 2.5: Risks to Water Supply by Hazard as per Regional Climate Change Risk Assessment. Source: Tonkin + Taylor, September 2021

To understand how climate change may influence the flow regime of the Ōhau River, HDC commissioned Williamson Water & Land Advisory Ltd[16] to develop a catchment model and assess a range of climate change scenarios i.e., RCP 2.6, 4.5, 6.0 and 8.5 for the years 2050 and 2100. The analysis considered the effect of seasonal change in precipitation as per NIWA predictions, but did not take into account potential temporal variations in rainfall.

The predicted impact of climate change on flow statistics for the Ōhau River at Rongomatane is given in Table 2.4.

[16] *Williamson Water & Land Advisory Ltd, letter dated 3 February 2022 to Damwatch Engineering Ltd "Poads Road WSR Hydrology Assessment".*

Table 2.4: Climate Change Scenario Summary Statistics for the Ōhau River at Rongomatane
Source: Williamson Water & Land Advisory Ltd, February 2022

Statistic	Historic	2030–2050				2081–2100			
		RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
Minimum (m^3/s)	0.423	0.417	0.415	0.411	0.413	0.429	0.412	0.408	0.383
25th Percentile (m^3/s)	2.175	2.185	2.187	2.178	2.182	2.219	2.194	2.195	2.152
Median (m^3/s)	4.132	4.187	4.204	4.174	4.193	4.296	4.241	4.254	4.151
Mean (m^3/s)	7.834	7.981	8.032	7.982	8.033	8.206	8.124	8.171	8.005
75th Percentile (m^3/s)	9.480	9.652	9.718	9.637	9.712	9.991	9.821	9.871	9.602
95th Percentile (m^3/s)	26.628	27.240	27.521	27.336	27.504	28.117	27.920	28.122	27.655
Maximum (m^3/s)	214.61	216.77	216.76	214.58	216.76	221.14	216.74	216.73	210.17

This assessment shows that by 2030 – 2050, climate change effects are predicted to have little impact on key flow statistics. By 2081 – 2100, climate change effects are predicted to result in a small reduction in low flow statistics for the higher order RCP climate scenarios.

As stated above, in the medium term, flow in the Ōhau River is most likely to be controlled by the weather patterns experienced and not gradual climate change. Risks associated with drought are expected to be similar to existing through to circa. 2050 (assessed as high risk on a regional scale), increasing to extreme (again, assessed at a regional scale) by 2100.

As identified in the regional climate risk assessment, the capacity of water supply is likely to have to rely on enhancement of storage and the ability to manage water demand levels.

2.6 Key Issues for the Existing Supply System

The key issues, constraints and risks associated with the raw water supply to Levin WTP and community supply are summarised in Table 2.5.

Table 2.5: Key Supply Features, Risks and Limitations

	Current Status	Key Issues, Constraints, Risks
Resource Consents	Consent secured to 2042 Abstraction limited to 15,000 m^3/day. Reduce abstraction to 13,000 m^3/day when river is at or below minimum flow.	Allocation insufficient to meet projected growth within the consent term (refer Section 3.4 below). Leakage standard in consent not met. Leakage condition set based on historic pressure settings of network. Unlikely to be achievable with lower network pressures as per pressure management system. Ongoing resourcing commitment required to maintain leakage within target levels. Subject to review in 2022 and 2032.
Existing Intake	Infiltration gallery ~900 m long, parallel to the river.	- Concerns re structural resilience/vulnerable to interruption. - Capacity limited to existing peak demand – may not be able to exercise full consented allocation. - Requires regular scarification (riverbed disturbance).
Water Quality	Treatment plant capacity (15,000 m^3/day) matches water allocation. Treated water meets NZDWS	Treatment capacity is insufficient to meet growth demands (refer section 3.3 for growth projection). Single water source so may be vulnerable to any changes in source water supply quantity or quality. Vulnerable to high-flow turbid water in river. New NZDWS and Quality Assurance Rules may affect compliance status.
Resilience	Treated water storage equivalent to approx. 1-day supply	No alternative water source in case of an emergency (eg earthquake). No long-term storage in event of severe drought or interruptions to supply.
	Vulnerability to high flow / high turbid conditions	No alternative source when river water turbidity is high and treatment plant production rates impacted as a result of high turbidity source water.
	Effects of climate change	Vulnerability of supply due to effects of climate change is unknown. Increased extremes may result in more frequent low flow events (restrictions in abstraction) and more frequent flood / high turbidity events.

The remainder of this report discusses the regulatory and policy matters influencing water supply, the amount of water required to meet future needs, and options to meet future needs and to address the matters identified above to the extent that these can be addressed from a supply perspective.

3 MEETING FUTURE NEEDS - WHAT'S REQUIRED?

The following sections discuss the various factors that will affect Levin's future demand for potable water. These factors include community growth, changing environmental and cultural expectations, climate change, and new regulatory regimes for the drinking water. For the purposes of this document, two planning timeframes have been adopted:

- A 20-year planning timeframe, to represent planning for the water supply through to the end of the current consent term i.e., 2042.
- A 50-year planning timeframe representing the minimum expected life of any significant investment in water infrastructure. It is noted that water infrastructure can be expected to have a life of 100-years or more for some assets. However, given the uncertainty associated with population projections, and the dynamic nature of the regulatory and environmental planning framework in which supply options must be considered, projections beyond a 50-year timeframe are unlikely to be reliable.

3.1 Council's Infrastructure Goals

The Council's Infrastructure Strategy identifies the following goals:

Goal 1	**Provide affordable levels of service through prudent infrastructure management.** Council will strive to ensure that the levels of service provided to the community are delivered at an affordable level. This will be achieved through careful asset management. This means Council will not over or under invest in maintenance and renewal treatments, and improvement work will be well planned to ensure expected levels of service are provided but not exceeded.
Goal 2	**Engage with our community to ensure customer expectations match infrastructure investment.** Council will foster stronger partnerships with our community. This will enable the community to gain a stronger understanding of infrastructure investment options and for Council to better understand the community's priorities and spending appetite.
Goal 3	**Ensure infrastructure is fit for purpose for our current community whilst also facilitating growth.** Horowhenua is experiencing unprecedented levels of growth, which presents significant infrastructure challenges. Council will strive to provide the infrastructure required to enable growth, while not compromising the affordability of infrastructure for our current community.
Goal 4	**Provide infrastructure which supports wellbeing and enables a sustainable community.** Council will provide infrastructure which supports and improves the wellbeing of the entire community, while delivering infrastructure which supports beneficial environmental outcomes.

Figure 3.1: Horowhenua District Council's Infrastructure Goals
Source: Horowhenua District Council's Infrastructure Strategy 2021 - 2051

3.2 Te Mana o te Wai

Te Mana o te Wai has been introduced into national regulation and policy as a fundamental concept for the management of freshwater in Aotearoa New Zealand. The National Policy Statement for Freshwater Management 2020 (NSPFM) requires that freshwater is managed in way that gives effect to Te Mana o te Wai. The Water Services Act 2021 requires the Council, as a water supplier, to give effect to Te Mana o te Wai when it exercises its power and performs its duties under the Water Services Act. This relates to not just drinking water, but also the delivery of stormwater and wastewater services. Te Mana o te Wai It is defined in NPSFM as follows:

> *"Te Mana o te Wai is 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."*

Further, the NPSFM states that Te Mana o te Wai encompasses six principles relating to the roles of tangata whenua and other New Zealanders in the management of freshwater (Figure 3.2).

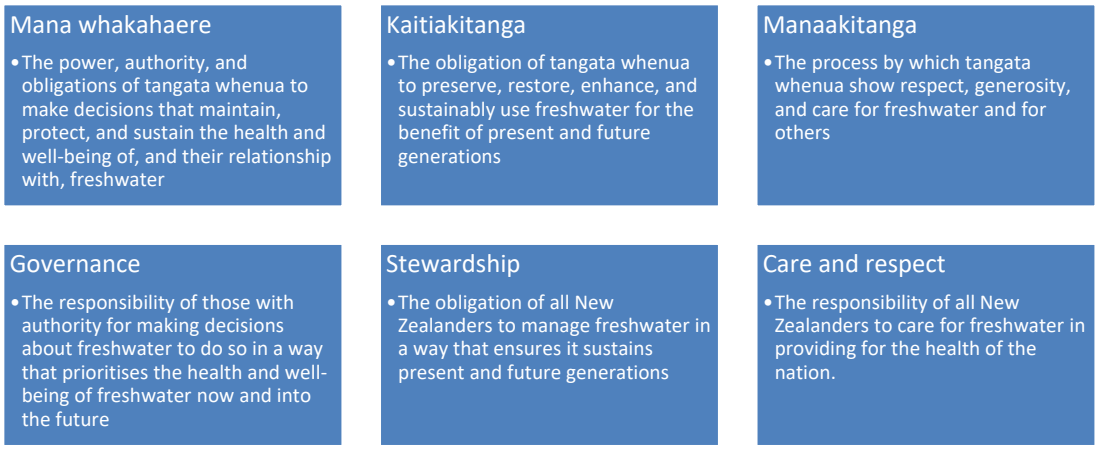


Figure 3.2: Te Mana o te Wai Principles

3.3 Community Growth Projections

Horowhenua District is experiencing a period of rapid growth which is expected to continue. Since 2014, the district has experienced a growth rate of 2% per annum, with the June 2021 population estimated at 36,708. This growth rate significantly exceeds that assumed when the existing water supply consent was sought. When the application for the current water supply consent was lodged in 2014, the growth projection was only 2% over the next 50 years (average growth rate of 0.04% per annum). At the time of the hearing, the growth projection had increased, but only to 0.4% per annum (i.e., only one-fifth of the growth experienced since the consent was initially sought).

Council commissioned Sense Partners Ltd to advise on projected economic and population growth for the district. In their May 2020 Projections Update report[17], the district was projected to grow more quickly than the national average, quicker than the average of the district over the past 10 years, and substantially more quickly than previous projections. The projected population median and 95th percentile growth figures are given in Table 3.1.

Table 3.1: District Population Projections
(Sense Partners Ltd, May 2020)

Year	Median Growth		95th Projection	
	Per annum	Total population	Per annum	Total population
2019		34,956		34,956
2029	1.8%	41,896	2.6%	44,968
2039	1.2%	47,006	2.8%	59,010
2049	1.0%	51,862	3.0%	79,243
2059	0.7%	55,626	2.9%	105,044
2069	0.6%	59,172	2.3%	131,741

For infrastructure planning purposes, the Council has adopted the 95th percentile projections set out above. This is summarised in the Council's Infrastructure Strategy 2021 - 2051:

> *"Moving forward our district's population is projected to grow at a rate of; 2.6% per annum from 2021 until 2031, increasing to 2.9% per annum until 2051. This means our population will increase to over 62,000 by 2041 and over 80,000 by 2051.*
>
> *The increase in population means the number of houses throughout the district will more than double by 2051. The current number of houses is estimated to be 16,606 as of June 2021. This is anticipated to grow by 21,145 to 37,751 by 2051."*

In Levin rapid growth is occurring with Council having recently (2022) completed rezoning of the Tara-Ika Plan Change area to provide for new residential development. Tara-Ika is located to the east of Levin and includes 420 ha which is now available for residential land use, together with some commercial and public areas to create a mixed-use urban area. Once fully developed, the Tara-Ika area will result in at least 3,500 additional homes.

The Council will notify further plan changes in the near future. These will provide additional growth areas close to Levin (identified in the Horowhenua Growth Strategy 2040) as well as additional infill development. This is in addition to the plan enabled capacity that already exists in Levin under the Operative District Plan.

As the Council has adopted the 95th percentile population projections for infrastructure planning, and this projected rapid growth is currently being experienced, this option's assessment adopts the same scenario.

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[17] *Sense Partners Ltd, May 2020, Horowhenua Socio-economic Projections Summary and Methods - Projections Update Report.*

It is recognised, however, that there is a risk that the growth projected may not be realised as quickly as anticipated. Therefore, for the purposes of assessing water demand and options for supplementing the existing water supply from the Ōhau River, a sensitivity analysis has been undertaken using median growth projections. This is detailed in Section 3.4.4.

3.4 Projected Water Demand for Levin Water Supply

This section adopts the above growth projection rates and applies these to Levin's current water demand to develop projected water demand requirements for water supply planning purposes. The projections assume that water demand is directly correlated with population growth (i.e., that per capita water demand does not vary). This is considered an appropriate basis for projections for purpose of infrastructure planning. In reality, the per capita water demand may vary if there is a change in the mix of residential to non-residential water users; or if water consumption patterns change or water efficiency improvements are made.

In terms of the mix of residential and non-residential water use, Council has some control over this factor via their Water Supply Bylaw and how they consider and approve applications for non-residential water connections. Any efficiency improvements will result in the actual water demand being below (less than) that projected in the following graphs and discussion. However, there is no certainty as to the quantum of efficiency or water conservation improvements that can be achieved. Therefore, the projections below are considered appropriate for the purpose of this water supply planning purposes.

The projections have been derived from measured water demand for the community over the last five years, as detailed in section 2.1.1. Note that this is the demand data (i.e. the amount of water supplied to the community as measured after the treated water storage reservoir) and does not include water abstracted on a non-consumptive basis (as allowed for in the consent to provide for backwashing in the treatment process). It also does not include any additional water abstracted at higher rates than the community demand, e.g. for purposes of filling the treated water reservoir. On average, over the last five years, the amount of water abstracted from the Ōhau River has exceeded the amount of water delivered to the community by 1,020 m^3/day.[18]

The following provides projections of the peak day, average day and annual water demand for the community. These are relevant as follows:

- **Peak day demand** is indicative of peak demand generally experienced during summer periods. Without bulk storage in the system (the current situation), it represents the daily abstraction required to be authorised via resource consent (i.e. the allocation required from the water resource). It also represents the treatment plant capacity required irrespective of whether bulk storage is provided, given that treated water storage is generally only 1 – 2 day's supply.
- **Average daily demand** is the average demand across the water year (i.e. 1 July to 30 June). Subject to sufficient bulk storage being provided, a resource consent allocation closer to the average daily demand may be sufficient. Storage is filled when demand is below average (typically in winter periods) and demand is met from the river and reservoir (i.e. the reservoir being drawn-down) when demand is above average (i.e. during summer months).
- **Annual water demand** is the total amount of water required to meet the demand for any given water year.

Further, and as discussed in Section 2.2.2, experience over recent years with addressing network efficiency via pressure management, water demand projections have also been made assuming two baseline data points as follows:

- The 2020/2021 water year represents a baseline assuming that active network management and leakage detection and repair is occurring at the upper end of expected levels. This was a water year where the Council's target of Band B for ILI was achieved for 6 out of 12 months.

[18] *Refer also to discussion on this in Section 2.1.*

- The 2018/2019 water year represents a baseline assuming active network management and leakage detection and repair was not occurring at expected levels. This was a water year where the Council's target of Band B for ILI was not achieved, as it was prior to implementing the pressure management system.

It is noted that there are many factors which influence overall water use. The summers of 2018/2019 and 2019/2020 were relatively dry and that contributed to the overall water use. This notwithstanding, the above baseline assumptions have been made based on feedback from Council staff responsible for the pressure management system and their analysis of leakage management.

It should be further noted that the 2018/2019 baseline and subsequent projections are presented only to indicate the impacts of not maintaining good network and leakage management. Active network and leakage management, to water industry standards, is critical and must be maintained on an ongoing basis. Further, from the 2022/2023 water year, there will be regulatory oversight of the network performance via the reporting of ILI and other performance measures to Taumata Arowai.

3.4.1 Peak Water Demand Projection

Figure 3.3 shows the projected peak water demand, being the maximum daily demand required by the community each year. This is projected using data from recent years, noting that water restrictions have generally been in place when the peak day demand was recorded. Figure 3.3 therefore shows the projected peak daily demand assuming the current water restriction policy continues to be implemented as a minimum.

Given that treated water storage is only 1-day's supply, the peak daily demand projections represent the water allocation required if there is no bulk storage in the system. This is the situation for the current system.

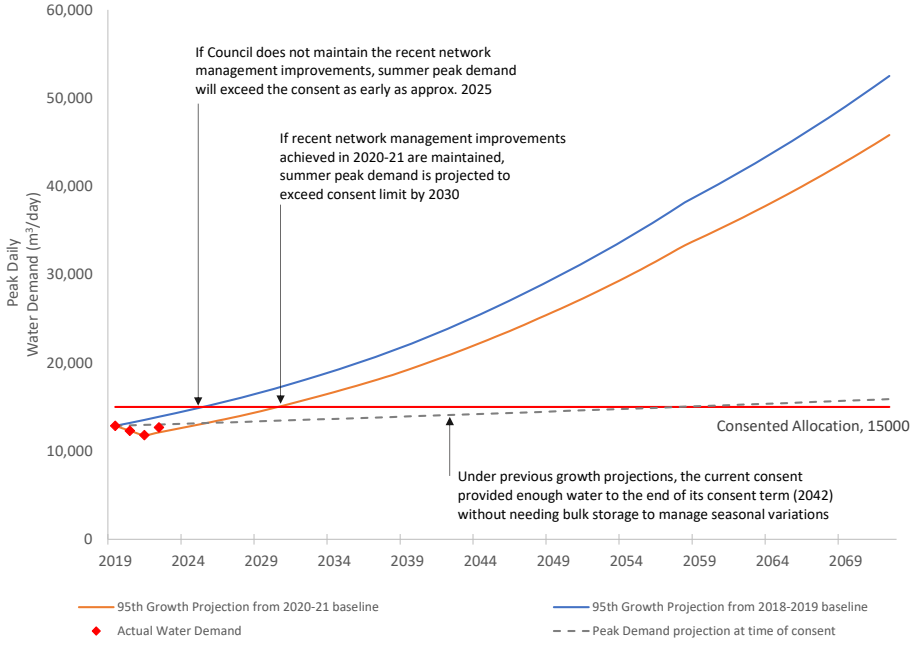


Figure 3.3: Peak Day Projections
Note: Peak day projection is indicative of resource consent allocation required if there is no bulk storage in the system; also indicative of treatment plant capacity required. Figure 3.3 assumes 95th percentile growth projection and similar per capita demand as existing. Refer to Section 3.4.4 for sensitivity analysis using median growth projection.

Figure 3.3 shows three different projections for the peak daily demand. These are:

- **Peak demand projection at time of consent:** This assumes a population growth of 0.4% per annum for the period 2015-2045. This is the growth projection that was adopted at the time that the existing consent went to hearing in May 2015. This growth rate is an order of magnitude

greater than that which was assumed in the application for the existing consent when it was lodged in 2014. There was projected to be only 2% growth in total over the next 50 years (i.e., an average growth rate of 0.04% per annum). Figure 3.3 shows that that growth projections available at the time the consent went to hearing indicated that the consent allocation of 15,000 m^3/day would be sufficient (albeit with no allowance for additional growth) to meet the community's peak water demands through to the end of the consent term in 2042. This is the basis on which the existing consent was granted.

- **Peak Demand based on Current 95th Percentile Growth Projections from the 2018-2019 water year baseline.** This baseline has been adopted to show the implications if the Council's recent network management improvements are not sustained**.** If the efficiency gains which were achieved between 2019 and 2021 are not sustained, the peak day demand could exceed the consented limit as early as 2025**.**
- **Peak Demand based on Current 95th Percentile Growth Projections from the 2020-2021 water year baseline**. This baseline has been adopted to project the peak demand assuming that the Council's recent network management improvements are sustained (and that the recent increase in the 2021-2022 water year is reversed). Even if the efficiency gains which were achieved between 2019 and 2021 are sustained, the peak day demand could exceed the consented limit by 2030. It also shows the importance of maintaining appropriate pressure management and addressing leakage in the system.

The above analysis shows that the existing consent does not provide sufficient water to meet the community's needs beyond 2030. It also shows the importance of maintaining appropriate pressure management and addressing leakage in the system.

3.4.2 Average Water Demand Projection

If bulk storage is provided, water allocation requirements can be based on average water demand rather than peak water demand (i.e., by filling up the storage when demand is less than average and drawing from the reservoir when demand is above average). The following therefore provides an analysis of demand projections based on average water demand.

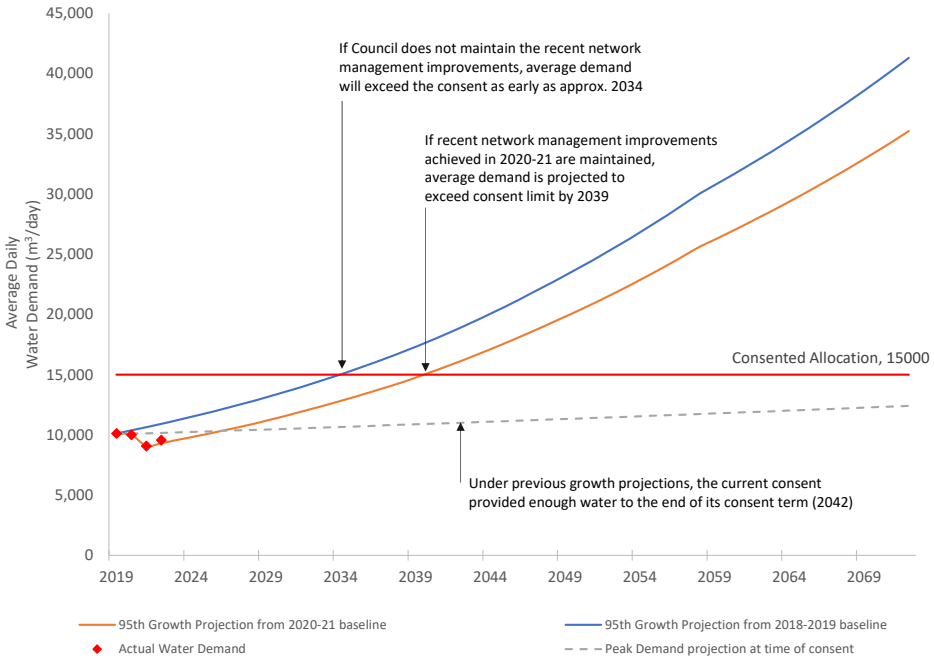


Figure 3.4: Average Day Demand Growth Projections

Figure 3.4 shows three different projections for the average daily demand. These are:

- **Average demand projection at time of consent:** This assumes a population growth of 0.4% per annum for the period 2015-2045. This is the growth projection that was adopted at the time that

the existing consent went to hearing in May 2015. This growth rate is an order of magnitude greater than that which was assumed in the application for the existing consent when it was lodged in 2014. There was projected to be only 2% growth over the next 50 years (i.e., an average growth rate of 0.04% per annum). Figure 3.4 shows that that growth projections available at the time the consent went to hearing indicated that the consent allocation of 15,000 m^3/day would be sufficient to meet the community's water demands through to the end of the consent term in 2042 and beyond if bulk storage is provided.

- **Average Demand based on Current 95th Percentile Growth Projections from the 2018-2019 water year baseline.** This baseline has been adopted to show the implications if the Council's recent network management improvements are not sustained. If the efficiency gains which were achieved between 2019 and 2021 are not sustained, the average day demand could exceed the consented limit as early as 2034**.**
- **Average Demand based on Current 95th Percentile Growth Projections from the 2020-2021 water year baseline**. This baseline has been adopted to project the average demand assuming that the Council's recent network management improvements are sustained**.** Even if the efficiency gains which were achieved between 2019 and 2021 are sustained, and water demand increases from the 2020 – 2021 baseline on a pro-rata basis with population projection, the average day demand could exceed the consented limit by 2039.

The above analysis shows that the existing consent does not provide sufficient water to meet the community's needs beyond 2039 even if raw water bulk storage is added to the supply system.

3.4.3 Annual Water Demand

Figure 3.5 shows projected water demand on an annual basis. This shows that, based on the projections that were available at the time the existing consent was determined, the consent provides sufficient water to meet the 50-year projected demand. However, because of the increased growth rates which have been experienced, and are projected to continue, the existing allocation is insufficient to meet the community's water demand over a 50-year planning timeframe.

Figure 3.5 includes two "available allocation" lines for comparison. The solid red line assumes that the consented 15,000 m^3/day is available to be abstracted 365 days per year. As discussed in Section 2.5.1 and Table 2.3, a 5-year return period event is likely to result in no days when river abstraction is constrained during low flow conditions. The solid red line in Figure 3.5 represents that scenario.

The dashed red line assumes that this is not the case, and the ability to abstract the full consented allocation is reduced as follows:

- For 16 days per year, water abstraction must be reduced because the river is below its minimum flow. This represents an estimated 50-year return period event. For planning purposes, the dashed red line in Figure 3.5 assumes that there is no abstraction when the river is below minimum flow.
- For up to 10 days per year, water abstraction must stop because of high turbidity in the river. Note that this is a conservative estimate and is highly variable depending on actual weather patterns and catchment conditions.

No analysis has been undertaken of the risk of having a year where both the above scenarios occur. The dashed red line in Figure 3.5 is therefore a conservative and only indicative of what may occur. It represents 26 days of no abstraction from the river for some reason. This is also equivalent of likely maximum consecutive days the river is below minimum flow in a 100-year return period event.

The above assumptions are indicative for planning purposes only. Natural flow variations are such that each year may have more or fewer restricted abstraction days than assumed above.

The assumptions above indicate a total abstraction approximately 7% less than if the existing resource consent was exercised fully.

Figure 3.5 shows that, depending on the degree to which abstraction from the river is constrained (at either low or high flows) and the demand projection assumed, there is a shortfall of 7.8 - 10.0 million m^3/year between projected community demand and the allocation available under the Council's existing consent, assuming a 50-year planning timeframe.

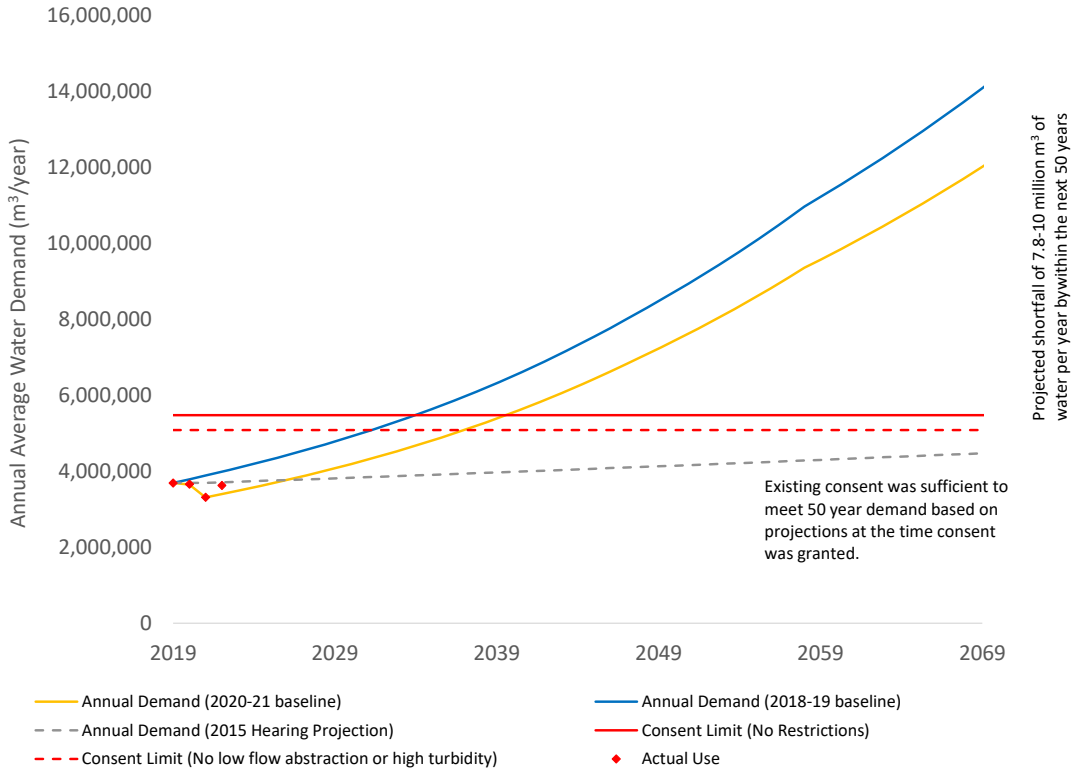


Figure 3.5: Annual Water Demand Projections

3.4.4 Sensitivity Analysis of Water Demand Projections

The growth projections noted above are based on the Council's adopted population projections for infrastructure planning. This represents the likely upper bound of potential population growth. There is a risk that these population projections may over-estimate the actual water demand that will be experienced.

To understand the degree to which water demand may vary from the projections above, the analysis was repeated using median growth projections. Graphs showing the 95th percentile and median projections are included in Appendix A. Table 3.2 summarises the outcomes of these analyses.

Table 3.2: Sensitivity analysis of median and 95th percentile population projections showing the year that the existing consent limit will be exceeded (existing consent expires 2042)

	Peak Day Projection (relevant to allocation required if no bulk storage as per existing system)		Average Day Projection (relevant to allocation required if bulk storage is provided)	
	Median Growth	**95th percentile growth**	**Median Growth**	**95th percentile growth**
If good network management is not maintained, consent will be exceeded in:	2028	2024	2051	2034
If good practice network management is maintained, consent will be exceeded in:	2038	2031	2072	2040

This analysis shows that:

- If actual growth is closer to the median growth projections:
  - The addition of sufficient bulk storage that the consented allocation can be based on the average day demand would mean that the existing consent allocation is sufficient to meet the community's needs through to 2051 and beyond.
  - If bulk storage is not provided, peak demand will exceed the consented limit by 2028 if good practice network management to minimise leakage is not maintained. The effect of investing in good practice network management extends this threshold to 2038.
- Maintaining good network management on an ongoing basis is critical to ensuring that water is used efficiently. The effect of investing in ongoing network management is to effectively extend the ability of the existing allocation to meet the community's needs by 7-10 years under peak day demand projections and 16-21 years at average day demand projections.

This assessment shows that there is a large variation, particularly towards the end of the 50-year planning horizon between the median and 95th percentile demand projections. These demand projections are based on a 'business as usual' per capita and per connection water use (ie they are the current use projected forward solely on population growth rates). There are numerous initiatives that may also be taken in terms of demand management to influence water demands. It is unlikely that community growth will be experienced at 95th percentile projection levels for the next 50-years. Therefore, it is more than likely that actual water demand will fall somewhere between the median and 95th percentile projections, although where it will be in this range is not able to be projected with confidence. Even if actual demand is closer to the median projections, this assessment shows that the existing consented allocation does not provide sufficient water to meet community needs unless bulk storage is incorporated into the system.

3.4.5 Impact of Potential Expansion of Network

The Council has separately commissioned feasibility reports[19] on the feasibility of supplying the communities of Ōhau and Waitarere Beach from the Levin supply. These reports have been reviewed to assess the likely additional water required should those communities be connected to the Levin supply. The feasibility reports determined the peak day demand for each community with growth allowance as per Council's Growth Strategy 2040.

Table 3.3: Additional Water Demand if Ōhau and Waitarere Beach communities are connected to the Levin Water Supply
From Green Infrastructure Ltd Feasibility Reports (2019, 2020)

Community	Average Day Demand, m^3/day	Peak Day Demand with 2040 Growth Allowance, m^3/day
Ōhau	410 m^3/day (see note)	783 m^3/day
Waitarere Beach	394 m^3/day	751 m^3/day
Total	804 m^3/day	1,534 m^3/day

Note: average demand for Ōhau was not estimated in the feasibility report. The figure in this table assumes the same average:peak ratio as Waitarere Beach.

The additional peak daily demand if both Ōhau and Waitarere Beach communities were to be connected to the Levin supply represents approximately 10% of the existing consented allocation. It also represents 5 – 8% of the projected water demand for Levin at year 2040.

The addition of these communities represent <10% of the projected 95th percentile growth water demand for Levin. Given the number of uncertainties associated with the demand projections, including whether predicted 95th percentile growth will occur, and the significant difference between

[19] *Green Infrastructure Services Ltd; September 2019; Feasibility Study for the Provision of Water Supply Services to Ōhau in Horowhenua District Council*

Green Infrastructure Services Ltd; January 2020; Feasibility Study – Provision of Water Services to Waitarere Beach

demand under median and 95th percentile projections, and that further demand management measures (such as rainwater tanks which will be required in the Tara-ika growth area) may reduce water demand, it is considered that the additional water required to service Ōhau and Waitarere Beach is within the level of uncertainty of the demand projections. Further assessment as to the viability of connecting these communities, and their impact on the Levin water supply, should be undertaken as part of any further feasibility assessment or preliminary design associated with proposals to connect these communities.

3.4.6 Summary of Water Demand Projections

The above projections show that:

- The increased rate of growth experienced by Levin means that additional water supply will be needed prior to the current consent's expiry date of 2042.
- The Council must continue to implement network improvements and pressure management to maintain the system within the Band B Infrastructure Leakage Index, or better. If this target is not met, there may be a shortage of water supply as early as 2025 if no bulk storage is added to the system.
- If bulk storage is provided and the network management / leakage reduction improvements are maintained, the existing consent only provides sufficient water through to 2039 under the 95th percentile growth projections. This timeframe is reduced to 2034 if network management / leakage reduction improvements are not maintained.
- Adopting a 50-year planning timeframe for water infrastructure demonstrates that the existing allocation does not provide sufficient water for the community's needs. The 50-year projection shows a shortfall between the existing allocation and community demand of between 7.4 and 10.2 million m^3/year, assuming the 95th percentile growth projection.
- There is a significant variation between median and 95th percentile projections towards the end of the planning timeframe. However, even if actual demand is more closely aligned to the median projection, the existing consented allocation does not provide sufficient water by the end of the consent term (2042) if bulk storage is not incorporated into the system (or some alternative means provided to meet summer peak period demands).
- If the communities of Ōhau and Waitarere Beach were to be connected to the Levin system, this would increase demand by less than 10%. This is within the level of uncertainty of demand projections. Further assessment of the viability of connecting these communities, and the resultant impact on the Levin water supply, should be undertaken prior to progressing with any proposals to connect these communities.

3.5 Climate Change Considerations

Water supply planning needs to consider and provide an adaptive pathway for responding to the likely effects of climate change. The "National Climate Change Risk Assessment for New Zealand" (MfE, August 2020), identifies the ten most significant climate change risks, based on urgency. The highest risk in terms of urgency is the "risk to potable water (availability and quality) due to changes in rainfall, temperature, drought, extreme weather events**,** and ongoing sea level rise". It rates the risk as "extreme" with an urgency rating of 93 out of 100. The potential for climate change to impact the Ōhau River and Levin Water Supply was discussed in Section 2.5.3.

3.6 Water Services Act

The Water Services Act 2021 sets out the regulatory requirements for how the Council provides its water services. Relevant obligations to this Water Supply Augmentation Operational Framework are:

- A duty of care to ensure that the drinking water supplied is safe (s21), aesthetically acceptable (s24), and that a sufficient quantity of water is provided (s25), noting that “sufficient quantity” is not defined.

- A requirement to identify, assess, manage and monitor risks to the sources of drinking water (Subpart 5 - Source Water). Suppliers must have a Source Water Risk Management Plan in place by November 2022. Land uses within the source water catchment and variability of source water quality will be key considerations in the assessment and management of source water risks.
- A requirement to monitor and report on the environmental performance of networks (Subpart 8). This includes a requirement to report against network performance measures such as leakage and efficiency, in accordance with rules published by Taumata Arowai, the water regulator. Section 3.6.1 below summarises the relevant proposed network performance measures (i.e. those measures that have a bearing on the quantity of water required to meet demand).

3.6.1 Proposed Network Environmental Performance Measures

Taumata Arowai has published proposed Network Environmental Performance Measures which Council will need to report against on an annual basis in accordance with Subpart 8 of the Water Services Act. These performance measures cover a range of matters, however the ones which are relevant to this report are those that relate to the quantum of water required to be supplied. This includes measures aimed at network efficiency and losses. These factors have a direct bearing on the amount of water which Council is required to abstract from the environment for supply purposes.

The relevant proposed Network Environmental Performance Measures are as follows; however, Taumata Arowai has not published any benchmarks / guidelines for acceptable levels of any of these measures:

- Drinking water services coverage: % of residential properties connected to drinking water.
- Water pressure: average system pressure
- Water restrictions: water restriction days (properties x days)
- Capacity to accommodate growth based on population projections and network capacity
- Network water losses:
  - Estimated network water loss (m^3/year)
  - Percentage Estimated Total Network Water Loss (%)
  - Current Annual Real Loss, to be measured as m^3/year; L/connection/day; and m^3/km mains/day
  - Unavoidable annual real loss, to be measured as m^3/year and L/connection/day
  - Leakage ratio (day:night flows)
- Alternative Water Use:
  - Volume of recycled water supplied to residential and non-residential customers
  - Volume of recycled water supplied to managed aquifer recharge
  - Volume of urban stormwater supplied to residential customer
- Efficient customer use of water: Average residential water consumption (L/person/day)
- Sufficient fire-fighting water availability: Fire hydrants testing the previous five years (%)
- Return to service post-natural disaster
  - Level of service during disaster
  - Level of service post disasters
  - Days to connect to post disaster service levels
  - Days taken to return to normal levels of service post disaster
- Ability to withstand drought: Target headroom (minimum buffer between supply and demand)
- Managing climate change risk: Mitigation / planning to manage risks associated with increases in extreme events.

3.7 Emergency Supply Requirements

The network performance measures detailed in Section 3.6.1 above include measures regarding the level of service provided during and post-disaster, as well as the number of days required to return to a normal level of service following a disaster. Taumata Arowai does not set targets for these values, nor does the Council currently have any defined level of service for post-disaster response for drinking water supplies.

To develop an initial guideline for emergency supply requirements, reference has been made to the approach of Wellington Water given their close geographical and similar seismic conditions. Wellington Water has identified that, following a major earthquake, the majority of the urban area would be without water for 15-30 days, with some parts being without water for more than 100 days. Wellington Water is establishing a network of above ground emergency storage locations to assist with supply following a major earthquake. Wellington Water has also established that households should provide for 20 L/person/day for the first seven days following an earthquake.

Considering the above, an initial post-earthquake level of service for the Levin water supply could be:

- Treated water storage sufficient to provide 20 L/person/day for 7-days
- Bulk storage sufficient to meet normal (average) demand for a period of 30 days. Note that, depending on the severity of the earthquake and likely duration to restore normal service, restrictions could be put in place to extend the supply period from this bulk storage.

3.7.1 Treated Water Storage

The treated water storage initial level of service proposed is therefore 20 L/person/day for 7-days. This provides a storage requirement shown in Figure 3.6.

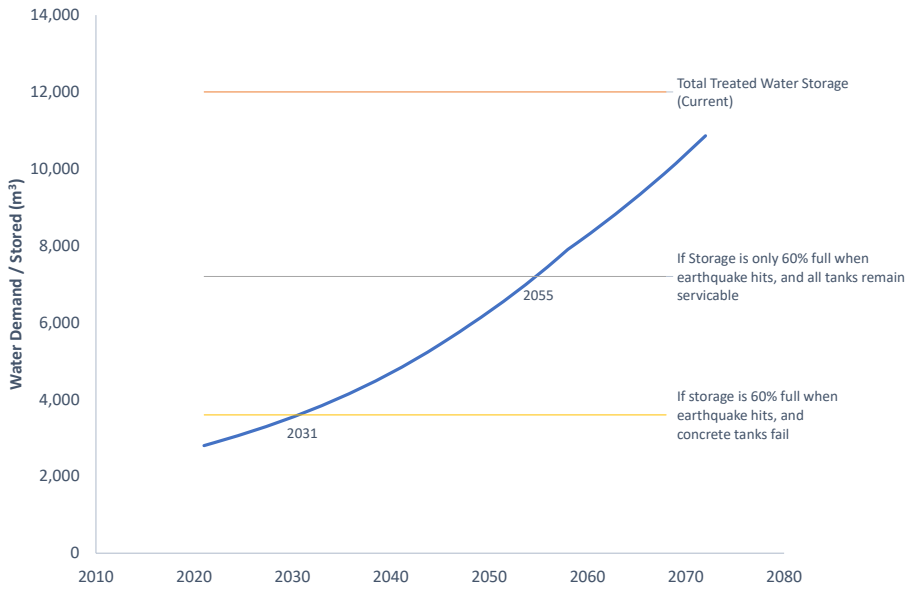


Figure 3.6: Treated Water Emergency Requirements

Figure 3.6 shows that, if this level of service is adopted:

- The current treated water reservoirs are unlikely to provide sufficient water. This is because they are unlikely to be full at the time of the earthquake, and the likelihood of the concrete tanks (total volume of 6,000 m^3) failing in a major earthquake. If the tanks are only 60% full when the earthquake hits, and the concrete tanks fail, then the remaining stored water is only sufficient to meet the 20 L/person/day for 7-day standard through until 2031.
- Additional storage is likely to be required by 2031. Consideration should be given to the location of any additional storage to maintain functionality of water supply in the immediate post-earthquake response period.

3.7.2 Bulk Water Storage

Assuming that an initial level of service of 30 days average water demand is adopted for the period between the emergency response phase and restoration of normal supply, the amount of bulk water storage required is shown in Figure 3.7.

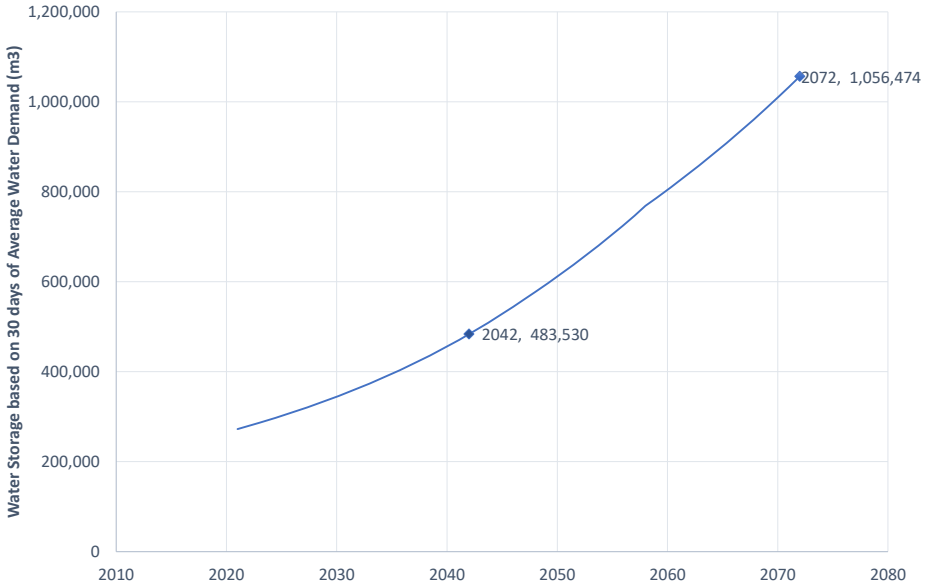


Figure 3.7: Storage Requirements to Meet Average demand for 30-days (Projected from 2020-2021 baseline)

By 2042 (the year that the current consent expires), and with current growth projections, storage of 480,000 m^3 will be required to be able to supply the community for a 30-day period.

By 2072 (50-year timeframe), the bulk storage volume requirement increases to approximately one million m^3.

Note that these assumptions are based on meeting supply at the annual average water demand levels and under the 95th percentile projections. If supply is restricted, the volume is reduced proportionally (i.e., if half of the annual average demand is to be provided, the volume required is also halved).

3.8 Drought Response

At present, the Council's abstraction from the Ōhau River is restricted at times when flow is below 0.820 m^3/s; the minimum flow specified in the One Plan for the Ōhau River. Under the existing consent, the Council can continue to abstract up to 13,000 m^3/day when the river is below the minimum flow (0.82 m^3/s). Similarly, if growth is less than 95th percentile levels, storage requirements to meet average demand post-earthquake will be reduced. Under median growth projections, the 2072 storage requirement to meet average demand for 30-days is approximately 450,000 m^3.

Section 2.5.1 discussed the Ōhau River flow regime and the frequency and duration of minimum flow conditions. The flow record shows that, since 1979, the river has been below minimum flow in six years, and the maximum number of consecutive days the river was below minimum flow is 25 days. Statistical analysis indicates that this would be a 1 in 100-year event. The river is most likely to be below minimum flow conditions in January to May. January to March are also months when demand is likely to be above average.

Figure 3.8 shows the range of storage volume or alternate supply required to meet supply during drought periods of different return periods for the number of consecutive days below minimum flow. Note that Figure 3.8 assumes that the demand is equivalent to the average water demand. However, the drought is likely to coincide with peak demand periods, and the demand is therefore likely to be

higher than assumed in Figure 3.8. Figure 3.8 assumes that strict water restrictions are in place during drought conditions.

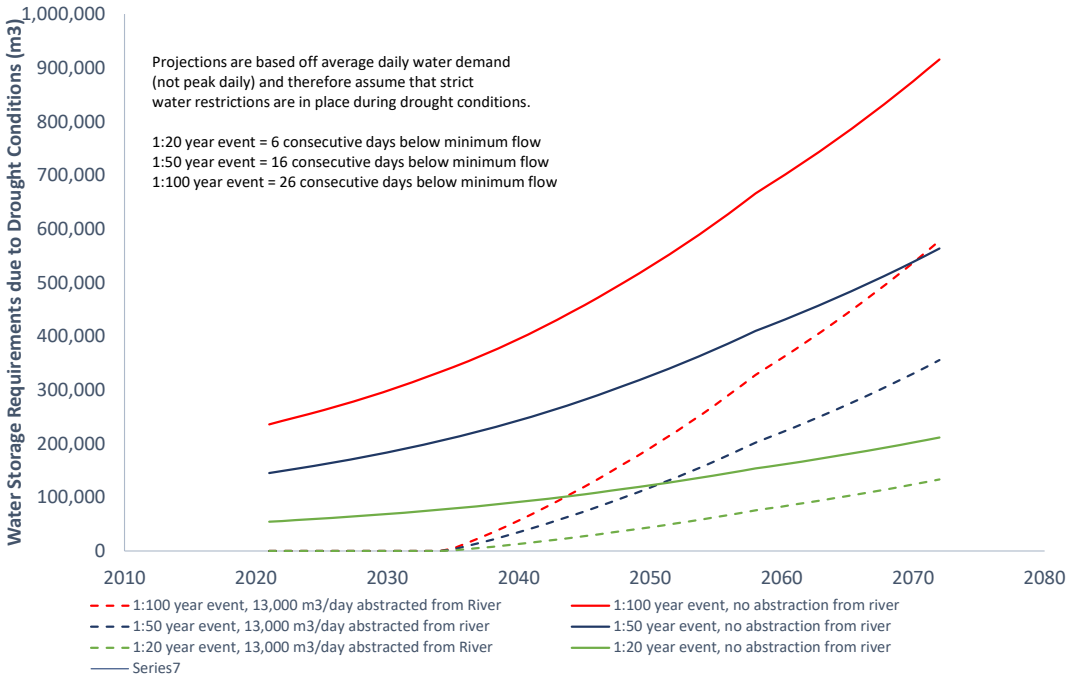


Figure 3.8: Drought Storage Requirements for Various Probabilities of Maximum Consecutive Days below Minimum Flow. Assuming Strict Water Restrictions are in Place (Supply = Average Daily Demand)

Dashed lines in Figure 3.8 assume that the Council can continue to abstract up to 13,000 m^3/day from the Ōhau River at or below minimum flow. This is as provided for in the existing consent. However, the regulatory framework (see section 3.8 below) generally requires abstractions to cease when a river is at or below minimum flow. Exceptions can be made where the abstraction is required to meet public water supply requirements. The existing consent was granted under this exception and taking into account that bulk storage or an alternative water supply was not available at the time consent was granted.

Should bulk storage or an alternative water supply be provided, it can be expected that Council's ability to abstract when the river is at or below minimum flow would be reviewed. Further, reducing or eliminating the Council's abstraction when the river is at or below minimum flow is likely to assist in giving effect to Te Mana o te Wai. The solid lines in Figure 3.8 indicate the likely storage requirements if there is no abstraction from the river at or below minimum flow.

Figure 3.8 shows that storage of 500,000 m^3 would be required to sustain supply at a rate equivalent to the average water demand over a 16-day period below minimum flow (a 50-year return period event). This volume is similar to the storage required to provide for the 1:100 year event if the existing consented abstraction below minimum flow is able to be exercised. It must be noted that these projections assume water demand is restricted to be no more than the average demand. Given that the drought is likely to coincide with hot, dry weather, when water demand is normally at its highest, this would require very strict water restrictions to be in place. These will need to be more severe than current water restriction policies.

Figure 3.9 shows the drought storage requirements assuming that the demand is closer to the peak daily demand. Note that this means that the current water restriction policy continues to be implemented as it is based on projections of the peak daily demand recorded in recent years which occurred at times when water restrictions have typically been in place. Figure 3.9 shows that storage of 730,000 m^3 would be required to sustain supply at a rate equivalent to the peak daily water demand over a 16-day period below minimum flow (a 50-year return period event).

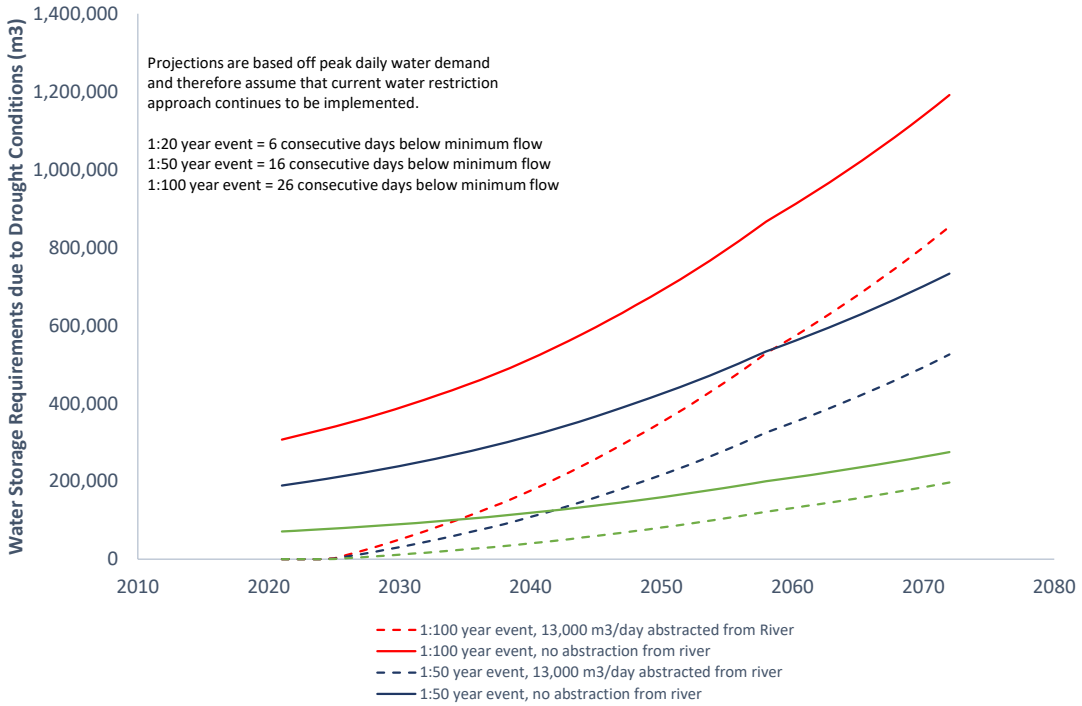


Figure 3.9: Drought Storage Requirements with Current Water Restrictions Practice in Place. (Supply = Peak Daily Demand)

3.9 RMA Regulatory Framework

The Resource Management Act (RMA) regulates the right to abstract freshwater and requires that a resource consent be obtained. The current resource consent for the Levin water supply has been summarised in Section 2.2 and expires in 2042. The resource consent can be reviewed by the consent authority (Horizons Regional Council) at ten yearly intervals prior to the expiry (i.e., in 2022 and 2032).

In considering a future water supply augmentation approach, consideration must be given to the expected regulatory framework for any new consenting needs and / or review outcomes. The following is based on the current RMA framework, noting that the RMA is currently subject to a reform process and a bill for the new legislative framework has been introduced to Parliament. However, it is not yet clear as to the likely outcomes of the reform process and a significant (likely 10-year) implementation timeframe is expected.

3.9.1 National Policy Statement on Freshwater Management 2020 (NPSFM)

The NPSFM establishes Te Mana o te Wai as the fundamental concept for management of freshwater and has a single objective "*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 NPSFM requires (among other things) that freshwater is managed in a way that gives effect to Te Mana o te Wai, and that freshwater be allocated and used efficiently. All existing over-allocation will be phased out and future over-allocation must be avoided. Regional Councils are required to set values and attributes for freshwater management and set limits for allocation. Under the Freshwater Planning Process (introduced via an amendment to the RMA), the Regional Council is required to notify a Regional Plan which gives effect to the NPSFM by 31 December 2024 and to make decisions on the notified plan within two years of notification.

3.9.2 Regional Policy Statement and Regional Plan

Horizons Regional Council's One Plan is the combined Regional Policy Statement and Regional Plan. It establishes the following allocation framework:

- A minimum river flow (0.82 m^3/s for the Ōhau as an average daily flow measured at Rongomatane) below which abstraction is expected to cease. Under Policy 5-18, exceptions can be made for essential takes such as public water supplies, however, a reduction in abstraction is required.
- A core allocation from which water may be allocated on a first-in, first-served basis. For the Ōhau River, the core allocation is 24,192 m^3/day and is fully allocated[20].
- A supplementary allocation which allows for water to be taken when the river is above median flow. The supplementary allocation available (i.e., the sum of all supplementary allocation takes) is 10% of any flow above the median.
- A calculation methodology for determining "reasonable and justifiable" needs for public water supply as set out in Policy 5-12 (normal) and Policy 5-18 (when the river is below minimum flow).
- A requirement that all water is used efficiently (as per policy 5-13).

As discussed above, it is expected that new Regional Plan provisions will be notified by 31 December 2024 to give effect to the NPSFM.

Section 2.1.1 included an analysis of current water use against Policy 5-12 and found that current use is "reasonable" as defined by that Policy.

3.9.3 National Policy Statement on Urban Development

The National Policy Statement on Urban Development 2020 (NPSUD) directs territorial authorities as to how they are to provide for well-functioning urban environments. It requires (Policy 2) District Council to "at all times, provide at least sufficient development capacity to meet expected demand for housing and for business land over the short term, medium term and long term". The NPSUD further defines sufficient development capacity be land that is, amongst other things, infrastructure-ready (clause 3.3(2)). The NPSUD therefore places a requirement on Council to ensure there is sufficient water available to provide for projected growth.

3.10 Summary

In summary:

- Improvements to Levin's current water supply are required to give effect to Te Mana o te Wai. Primarily this requires engaging with iwi and hapū to determine how Te Mana o te Wai will be given effect to in the context of the Levin water supply, and how the relationship between Council and iwi and hapū will be fostered. Further, it is expected that giving effect to Te Mana o te Wai will require a reduction (if not a cessation) in the amount of water which can be abstracted under low flow conditions. This will require an alternative water source, bulk storage and / or water use reductions and restrictions to be implemented.
- Projected growth is significantly greater than anticipated at the time that the Levin water supply consent was obtained. Without an alternate water source or bulk storage, summer demand could exceed consented supply as early as 2025. If bulk storage is added to the system, the existing consent is likely to provide sufficient water until about 2039. Beyond that date, an additional water source will be required.
- Assuming a 50-year planning timeframe, the existing consent has a shortfall of supply of 7.8 - 10.0 million m^3/year.

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[20] *HDC applied for consent to abstract the remaining core allocation (409 m^3/day) as advised early 2022 to be taken at a future intake site upstream of the existing intake. This has since been granted and this water is now allocated to HDC via resource consent ATH-202205111.00 granted on 15 November 2022. There is no more core allocation water in the Oahu River available to be allocated.*

- All the above projections assume that the Council continues to implement network improvement measures and pressure management to maintain the system within the Council's adopted target of Band B Infrastructure Leakage Index or better. This is also required to meet Regional Policy Statement provisions as to what is considered reasonable and justifiable demand for a public water supply.
- An alternate water source and / or off-river storage is required to improve the resilience of the supply against drought conditions and high-flow, high-turbidity conditions in the Ōhau River. To provide an effective drought response for a 1:50-year event, storage of 500,000-700,000 m^3 is required, and / or an alternate water source not susceptible to the same drought conditions as the Ōhau River is required.
- Post-emergency supply provisions have been assessed as follows:
  - Immediate response period of 7-days, supplying 20 L/person/day. The current treated water storage is unlikely to meet this requirement by 2031. A total of 10-12,000 m^3 effective storage is recommended to meet this level of service at the 50-year timeframe.
  - Bulk storage to provide up to 30 days supply at average demand. To meet this requirement 480,000 m^3 will be required by 2042 and 1,000,000 m^3 will be required by 2072.

The next section of this document assesses options for meeting these supply requirements.

4 OPTIONS ASSESSMENT

This section summarises the options which have been identified as ways in which Council could increase the supply and security of source water for the Levin community. This includes the assessment of those options to identify a preferred option for further investigation and development. The options have been identified through a multi-disciplinary team comprising Council officers and independent consultants. Section 4.1 sets out the identified options and provides a brief description of each. Section 4.2 and Appendix B detail the assessment of these options against a multi-criteria analysis and identifies the preferred option.

4.1 Description of Identified Options

Figure 4.1 summarises the various options that were considered. As noted above, these options have been identified through a multi-disciplinary team comprising Council officers and independent consultants in the engineering and planning disciplines[21].

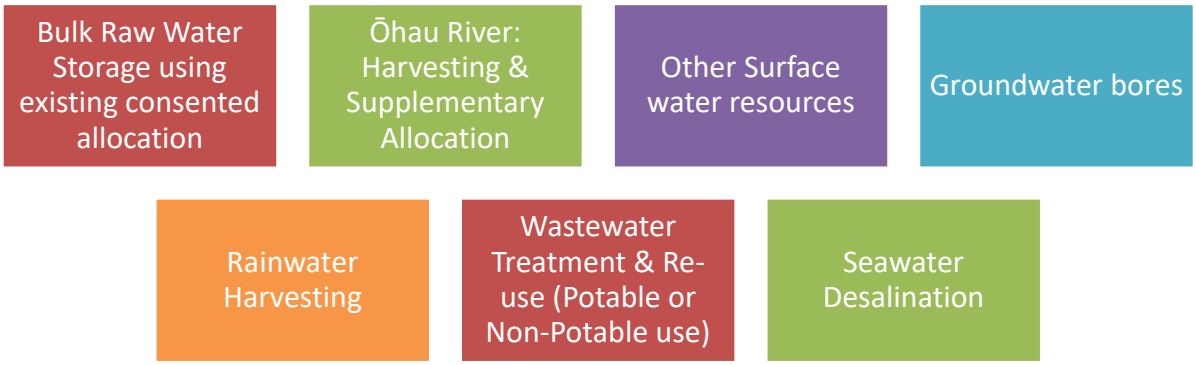


Figure 4.1: Options Identified for Assessment

The following provides a brief description of the identified options. A multi-criteria analysis of the options is presented in Section 4.2.

[21] *HDC project manager; Blue Bay Engineering Ltd; Damwatch Engineering; Good Earth Matters Consulting Ltd.*

4.1.1 Bulk Raw Water Storage Using Existing Consented Allocation

This option involves construction of a large (multi-day supply capacity) storage for raw (untreated) water. It typically involves a large reservoir constructed off-river where water is stored for later use either to meet shortfall between community demand and supply from the source, or to meet demand when source water supply is interrupted. For Levin, a bulk raw water storage facility could be used to:

- Provide water for the community when the river is at or below its minimum flow, by either:
  - Avoiding abstraction when the river is at or below minimum flow by supplying the community entirely from the storage reservoir. Volume required by 2042 is up to 500,000 m^3 depending on the demand and number of consecutive days that the river is below minimum flow.
  - Reducing / minimising abstraction when the river is at or below minimum flow by supplying the community partly from the river and partly from the reservoir. The amount of water required in this configuration depends on the degree to which abstraction from the river is reduced at times of minimum flow. If the existing minimum-flow allocation of 13,000 m^3/day is exercised, then the volume required by 2042 is 210,000 m^3, depending on demand and the number of consecutive days that the river is below minimum flow.
- Providing "top up" water for meeting growth demands when the peak community demand exceeds that available through the current allocation.
- Providing water to the community when the river is too turbid to efficiently and effectively treat water directly from the river.
- Providing water to the community in the event that abstraction from the river is interrupted e.g. during to earthquake. This could either be via the treatment plant, or direct from tankers to the community (as non-potable water supply) in the event that conveyance and treatment facilities are affected.

The size of the reservoir required depends on the degree to which the above factors are coincident and / or occur in close succession. For assessment purposes, a storage volume equivalent to 30-day average demand has been assumed. By 2042, this will require a storage volume of 480,000 m^3. This is increased to approximately one million m^3 if considering a 50-year planning timeframe.

A reservoir reliant on the existing consented allocation can only assist in meeting the community's needs through to between 2030 and 2036. After this, the annual demand will exceed that which is available under the existing consent (Figure 3.5). An additional consented water source to be able to fill the reservoir is required beyond this date. Options to secure additional consented water are discussed below.

An off-river reservoir is consistent with the policy direction of the Regional Policy Statement, in particularly policy 5-13 which promotes water storage as a means to achieving efficient use of water.

This option is limited to an off-river storage reservoir only. An on-river reservoir (i.e., dam and lake reservoir) is not considered feasible or desirable for the following reasons:

- An on-river dam and reservoir is contrary to the principle of Te Mana o te Wai as it would have a significant adverse effect on the mauri and the health and well-being of the awa and freshwater ecosystems.
- An on-river dam and reservoir would be highly unlikely to be supported by mana whenua and is unlikely to be able to gain the necessary resource consents under national and regional regulation (i.e. the NES-Freshwater and Regional Plan).
- There is a major fault line along the Ōhau River which would affect the dam engineering requirements, reliability and safety.

For these reasons, on-river storage is not considered a viable option and has not been considered in the options assessment.

4.1.2 Ōhau River: Water Harvesting (Reservoir) + Supplementary Allocation

The amount of water available for allocation from the Ōhau River is prescribed in the water allocation framework in the Regional Policy Statement and Regional Plan. This is summarised in the following diagram.

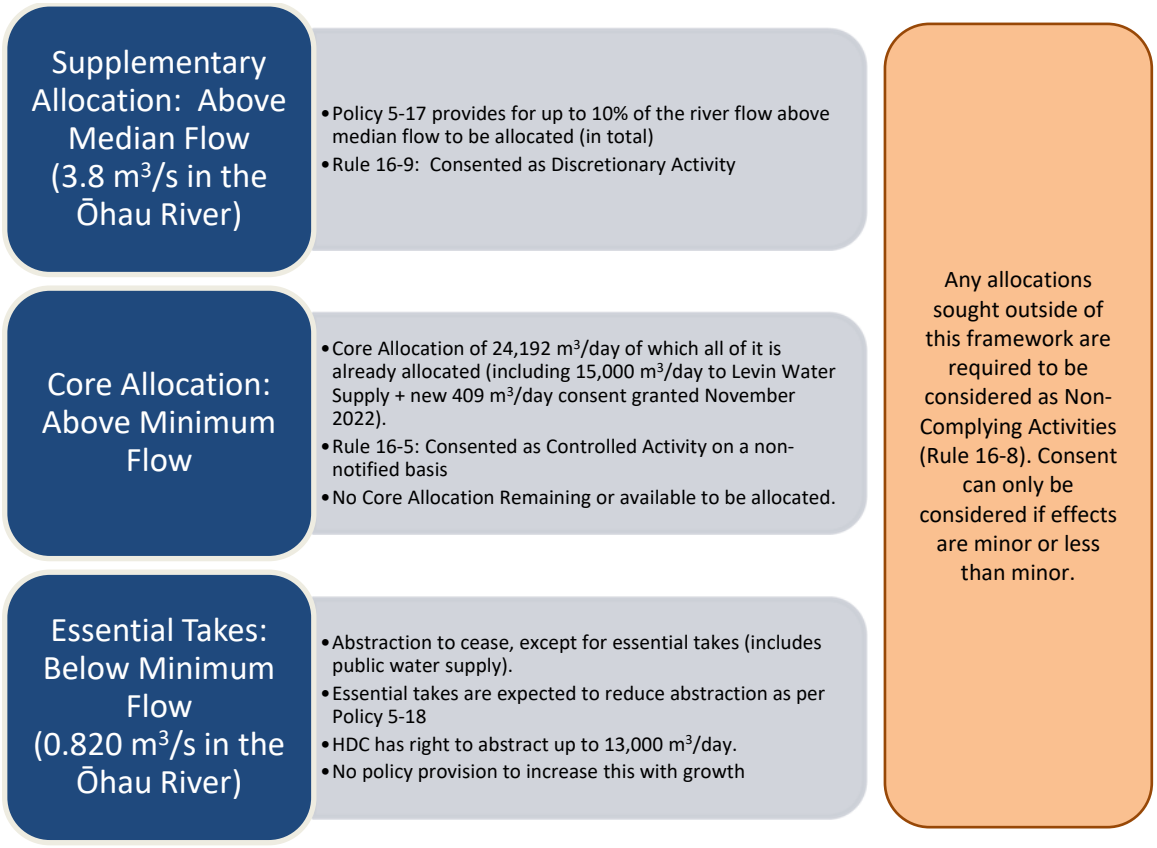


Figure 4.2: Summary of One Plan Allocation Policies and Rules

As set out in Figure 4.2, the Regional Policy Statement and Regional Plan establishes an allocation framework as follows:

- **When the river is below its minimum flow** (which, for the Ōhau River, is 0.820 m³/s measured at the Rongomatane flow gauging site and assessed as a daily average, as defined in Schedule C of the One Plan), all takes are required to cease. An exception is provided for essential takes under Policy 5-18, including for public water supplies, however, Policy 5-18 requires that abstractions for essential takes are reduced as far as practicable. For Levin, the existing consent requires that the abstraction be reduced to 13,000 m³/day below minimum flow and that water restrictions are imposed in accordance with the Water Demand Management Plan. The policy does not include any provisions that enable the minimum flow allocation for essential water supplies to be increased to address growth**.** That is, the policy clearly expects water suppliers to meet growth demands without increasing abstraction at times of minimum flow.
- **A Core Allocation limit** has been established which is available for allocation on a first-in, first-served basis. Core Allocation is available when the river is above minimum flow and is provided for under Rule 16-5 of the Regional Plan. For the Ōhau River, the core allocation is set at 24,192 m³/day, however, this is fully allocated. No further core allocation consents can be granted.
- **Supplementary Allocation is provided via Policy 5-17.** Supplementary allocation is available when the river is above median flow (i.e., on average 50% of the time). The supplementary allocation is 10% of the flow above the median (i.e., as flow increases more allocation is available). There is no specific rule in the One Plan which provides for supplementary allocation and

therefore applications for supplementary allocation are required to be considered under the General "Other takes and uses of water" Rule 16-9 as a Discretionary Activity.

- **Applications for water allocation which do not fall within the above allocation framework can be made via Rule 16-8 of the Regional Plan. As such, the application would be considered as a Non-Complying Activity**. Section 104D of the Resource Management Act states that a consent may only be granted for a Non-Complying activity if either a) the effects will be minor, or b) it will not be contrary to the objectives and policies of the Regional Plan. By definition, an application for a water allocation which falls outside of the above framework will be contrary to the objectives and policies of the plan, and therefore consent can only be granted if the effects are minor or less than minor.

As noted above, there is no water remaining from the core allocation for the Ōhau River and no additional water can or should be sought when the river is below minimum flow. Therefore, the only water available to be allocated under the One Plan allocation framework is from the supplementary allocation.

A preliminary hydrological assessment has been undertaken of the availability of supplementary allocation water from the Ōhau River (Appendix C)[22]. This found that:

- The amount of water available is variable annually and depends on the amount of time that the river is above median flow as well as the magnitude and duration of flows that occur above the median.
- Based on the hydrological flow record (42-year record from 1 July 1970 to 30 June 2021):
  - Total supplementary allocation available averages 22.6 million m^3/year,
  - If abstraction does not occur when the river is above 5 times the median flow (being the interim flow threshold adopted to avoid abstracting highly turbid source water), the supplementary allocation averages 10.6 million m^3/year.

As discussed in Section 2.5.2, the interim high-flow threshold is subject to further analysis and refinement following an in-river monitoring programme currently being implemented. However, the interim flow threshold adopted is conservative and likely to result in an under-estimation of available supplementary allocation. Further, if needed, additional engineering and pre-treatment options (eg selection of pumps capable of pumping higher turbidity water and settling ponds) could be adopted to abstract and use higher turbidity water without compromising compliance with drinking water standards.

In summary, additional water from the Ōhau River within the Regional Plan allocation framework is likely only available when the river is above median flow. There is sufficient water available above median flow to meet the community's needs for the 50-year planning timeframe. However, as the water can only be abstracted when the river is above median flow, this option must be implemented in conjunction with large scale, raw water storage, as described in Section 4.1.1.

Sourcing additional water from the Ōhau River via water harvesting above median flow has benefits of not introducing an alternative water source of different quality, i.e. it reduces the need to introduce a different water treatment process; reduces infrastructure requirements of connecting a geographically separate secondary source; and also avoids the need to assess and manage risks associated with a second source water area.

4.1.3 Other Surface Water Resources

This option involves sourcing additional water from a different surface water catchment. The catchments close to Levin are shown in Figure 4.3.

[22] *Keane Associates Ltd letter to Damwatch Engineering Ltd, dated 24 November 2021*

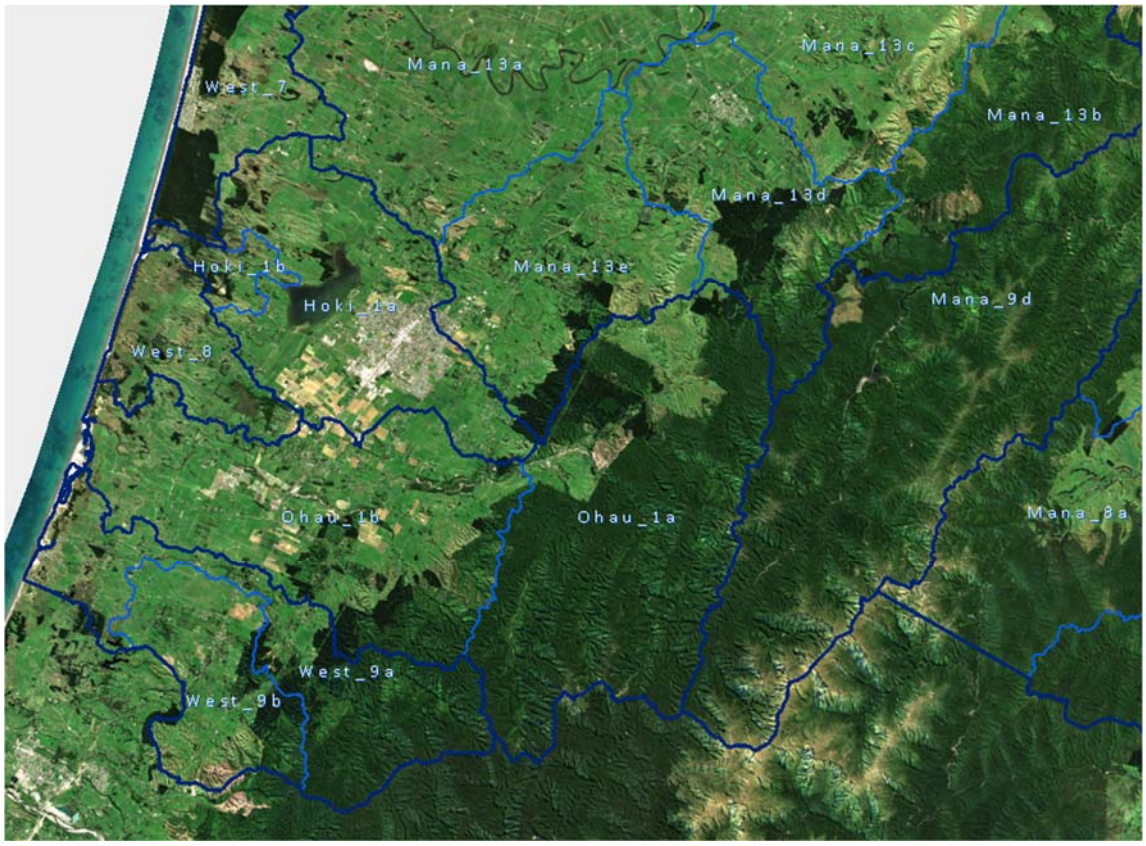


Figure 4.3: Water Management Catchments (Sub-Zones as per One Plan). Source: Horizons Online Maps - Public Viewer, One Plan Map

In addition to the catchments identified in Figure 4.3, the Ōtaki catchment to the south is shown in Figure 4.3. However, this catchment is within the Greater Wellington Regional Council jurisdiction and any use of the Ōtaki water would require a cross-regional allocation. Further, and perhaps more importantly, this option is likely to be unacceptable from a cultural perspective, given that it would involve a transfer across catchments and rohe.

Table 4.1 summarises the water availability and water quality for the catchments near to Levin.

The assessment in Table 4.1 is based on water available for allocation under the Regional Plan allocation framework. An analysis of the hydrological regime has not been undertaken for the purposes of this report. It is noted that most of these surface water sources (i.e., all except the Manawatū River) are significantly smaller and have more variable flows than the Ōhau River. They are likely to be subject to abstraction restrictions more frequently and for longer than the Ōhau River.

Table 4.1: Alternative Source Water Resources

(Note Ōhau_1a and Ōhau_1b identified in Figure 4.3 not included. These catchments are the Ōhau River which have been assessed in section 4.1.2 above; Allocation totals in Table 4.1 are sourced from Horizons database information provided March 2022)

Surface Water Catchment	Quantity Available	Commentary
Waikawa West_9a	6,048 m^3/day core allocation; 4,222 m^3/day available	If the remaining core allocation is confirmed and secured, this combined with the current allocation from the Ōhau River would provide for peak day demand needs through to 2034-2039. If storage is added to the system such that allocation only needs to meet average demand, then this source plus the Ōhau River could meet community needs through to 2042-2048. Approximately 15km of supply pipeline would be required to connect to the Levin network assuming the water was treated separately at a new treatment plant. If the supply were to be connected as a raw water line to the existing treatment plant, approximately 20 km of supply pipeline would be required.
Manukau West_9b	432 m^3/day core allocation; 156 m^3/day available	Insufficient water available for allocation
Lake Papaitonga (West_8) and Waitarere (West_7)	10% of Mean Annual Low Flow (MALF) No current allocations	This is a relatively small catchment and therefore available allocation is likely to be insufficient to make a meaningful contribution towards community's needs.
Lake Horowhenua and Hokio Stream Hokio_1a and Hokio_1b	10% of MALF No current allocations	Hokio Stream MALF is likely to be relatively low such that there will be insufficient water available for allocation. Lake Horowhenua is known to be of degraded water quality and this would result in poor source water quality and increased treatment requirements. Lake Horowhenua is a taonga for mana whenua and abstraction is likely to have significant cultural effects.
Upper Mangahao Mana_9d	7,344 m^3/day core allocation; 4913 m^3/day available	Similar allocation available as with Waikawa above. Therefore this, along with the Ōhau River, could provide sufficient water to meet demand through to 2034-2039 without storage, or 2042-2048 with storage. The Upper Mangahao flows to the eastern side of the Tararua Ranges and therefore sourcing water from this catchment would require water to be diverted to the western side of the ranges (which currently occurs to an extent as part of the Mangahao power scheme). It is considered that further diversion of water to the western catchment would be considered unacceptable from a cultural and environmental perspective. Further the intake and pipeline route would be on and through conservation land and likely to cause significant disruption to native vegetation and habitat.
Koputaroa Mana_13e	432 m^3/day core allocation; 351 m^3/day available.	Insufficient allocatable water to be considered a viable source.
Mangaore Mana_13d	10% of MALF 6,098 m^3/day allocated	Shannon water supply is abstracted from this sub-zone. Assessments undertaken as part of the Shannon water supply consent process indicate this water source is either fully, or potentially over allocated. No water available for this to be considered a viable source.

Surface Water Catchment	Quantity Available	Commentary
Tokomaru Mana_13b & Mana_13c	14,688 m^3/day core allocation (Lower Tokomaru) 6,208 m^3/day available	Tokomaru water supply is abstracted from Mana_13c sub-zone. The remaining allocation is predominantly available in the lower Tokomaru River (as the upper Tokomaru River only has 1,296 m^3/day available). The existing Tokomaru water supply intake is from the upper reaches of the Lower Tokomaru Zone. Remaining allocation in this zone could (in conjunction with the Ōhau River allocation) provide sufficient water to meet peak day demands to 2038-2042. If storage is provided, it could provide sufficient water to meet demand through to 2046-2051. Assuming an intake in the same general location as the Tokomaru water supply intake, there would be approximately 30 km of supply pipeline required to connect to the Levin network.
Manawatū River Coastal Manawatu Mana_13a	598,752 m^3/day core allocation; 250,000 m^3/day available	More than sufficient water available for allocation. However, this would need to be taken from the lower reaches of the Manawatu River (downstream of the confluence with the Oroua River). The river has an extensive catchment at this site and water quality is considered to be poor. The LAWA online database identifies the Manawatū River at Opiki (just upstream of this zone) as being in the worst 50% of all sites for E Coli, Total Nitrogen, Dissolved Organic Nitrogen, Nitrate-N, and Dissolved Reactive Phosphorus. It is in the worst 25% of all sites for clarity, turbidity, ammoniacal-N and Total Phosphorus. Further, the trends for all of these parameters are degrading or indeterminate and none of the parameters are showing an improving trend. This source would have significant source water quality risks which would need to be managed and would require a new treatment plant. The conveyance route from the Manawatū River to Levin community is in the order of 30 km.
Otaki River	Unknown	The Ōtaki River is recognised in the Greater Wellington Regional Plan as a water body with outstanding indigenous ecological value; a taonga of significant value to Ngā hapū o Ōtaki; a significant contact recreation freshwater body; and an important trout fishery. There are significant challenges associated with addressing cultural values and community expectations if an out of region source such as the Ōtaki River were to be pursued. This option is likely to be unacceptable from a cultural perspective. Conveyance distance from this source to Levin is 20-25 km.

In summary, there are only four surface water resources in the area that could provide sufficient water to assist to meet the community's future water demands. These are the Waikawa, Upper Mangahao, Tokomaru and Manawatū Rivers. The Upper Mangahao is not considered feasible as it would transfer water from the eastern catchment to the western catchment of the Tararua Ranges. This is likely to be culturally and environmentally unacceptable. The Tokomaru River could provide good quality water that is known to be suitable for drinking water (given the Tokomaru water supply comes from the same source) but would require 30+ km of new supply pipeline. Further, there are significant cultural concerns with transfer of water between catchments that would need to be understood and addressed before this option was considered further. The Manawatū River is not recommended because of water quality concerns as well as significant conveyance costs (30+ km of pipeline). There are also similar concerns regarding the transfer of water between catchments.

The Waikawa Stream may be a viable source. If it were to be pursued, bulk storage would also need to be developed to meet community needs beyond 2034. Conveyance routes are 15-20km. Potential cultural concerns regarding transfer of water between catchments, as well as water quality issues, would need to be assessed in the first instance to determine if this is a viable option.

Further, as noted above, these rivers are likely to be subject to the same climatic variability as the Ōhau River and potential periods where abstraction would be restricted are likely to be experienced more frequently and more persistently compared to the Ōhau River.

4.1.4 Groundwater Bores

This option would involve constructing, and abstracting water from, a series of groundwater bores within, or close to, the Levin water supply area. To assess this option, publicly available information as to the availability and quality of groundwater resources has been referenced, together with the assessment of this option which was included in the consent hearing for the existing Ōhau River abstraction consent.

The bores would be located within the Horowhenua groundwater management zone as defined by Schedule D of the One Plan. Under the One Plan, there is 27 million cubic metres per year available to be allocated from this groundwater management zone. While from a planning perspective groundwater allocation is considered separately to surface water allocation, it must be recognised that groundwater is hydraulically connected to surface water.

The water resource of the Ōhau catchment is now considered by the consent authority as a single resource, including both surface water and any interacting groundwater. This means that, unless it can be shown conclusively that water from a groundwater bore has no interaction with surface water features, abstraction is more than likely to be treated as if it was directly from the Ōhau River and subject to the same restrictions. As stated previously, the core allocation of water from the Ōhau catchment is fully allocated already.

A 2019 report prepared by PDP Ltd as technical advisors to Horizons Regional Council[23] considered the effects of groundwater abstraction on Lake Horowhenua. It identified the importance of groundwater inflow to the lake and noted:

- Consented allocation is estimated at 2.083 million m^3/year. This is up from 0.7 million m^3/year estimated by PDP Ltd in their earlier 2014 report.
- Estimated actual use of 0.419 million m^3/year is only a portion of current consented allocation. This estimate increases to approximately 0.79 million m^3/year if permitted takes are added to the estimate.
- Of the actual use, 69% of the total annual allocation occurs during summer (December to February), a period when there are generally lower inflows and outflows to the lake.

[23] *PDP Ltd, October 2019, Lake Horowhenua Water Balance Assessment and Quantification of Uncertainties-2019 update; report prepared for Horizons Regional Council.*

The PDP report found that (emphasis added):

> *"The consented volume of groundwater abstraction is large compared to groundwater inflows. On the face of the potential effect from consented volumes,* ***there should be no more abstractions allowed from within the catchment of a lake that is experiencing adverse effects that are made worse by a lack of throughflow and an increase in residence time.*** *However, based on water use data, it is also clear that the majority of users do not utilise their consented volumes. Therefore, as consents approach their expiry date and come up for renewal, a review of the allocation allowance should be undertaken for each consent to ensure it reflects realistic use requirements, taking into account past water use records. Based on flow meter records to date, this assessment of realistic water use requirements has the potential to make a meaningful reduction in consented allocation and reduce the potential for groundwater allocation to affect the lake health.*
>
> *…*
>
> *Until … limits are defined and set an interim approach to consent applications should avoid any increase in the currently consented volume and should seek to reduce that volume as applications are received to replace or transfer existing consents. Based on the available data comparing consented volumes to actual metered water use, a reduction in the existing annual volume of at least 50% would be realistic and achievable without unduly restricting water use in the area."*

That is, the technical assessment by PDP Ltd is recommending a policy approach to reduce existing allocations (of approximately 2 million m^3/year) by 50% to avoid adverse effects of the lake. To put this into context, the demand projections in Section 3 indicate that an additional 7 – 10 million m^3/year will be required to meet the 95th percentile growth projections over a 50-year planning timeframe.

At the consent hearing for the existing abstraction from the Ōhau River, evidence was presented [24] that the option of groundwater bores was not viable for the following reasons:

- The cost of investigating and exploring the option is significant, being estimated at $2-4 million with no certainty that this investigation would yield a viable alternative water supply.
- If this investigation found that groundwater bores was a viable alternative, it would cost $9-15 million to develop the option.
- Chances of gaining consent for a groundwater borefield were considered "slim" because of the likely potential impacts on Lake Horowhenua.
- Further time to explore alternatives would result in significant delays in meeting Drinking Water Standards which, at the time, was "already an urgent objective for HDC".

While the concern as to timeframes to achieve a complaint drinking water quality are no longer relevant, the concerns expressed above regarding cost and impacts on Lake Horowhenua remain valid.

Specifically, it is likely that any further abstraction of groundwater would have a potential adverse effect on Lake Horowhenua. Given the current state of knowledge, it would most likely be extremely difficult, costly and time consuming to demonstrate effects are acceptable to the level required to enable consent to be granted.

Horizons 2019 State of the Environment report provides a high-level commentary on groundwater quality throughout the region. Of relevance to the Horowhenua and Levin area, it notes:

- Although groundwater nitrate concentrations throughout the majority of the region are below the drinking water standards, nitrate concentrations are elevated in the Horowhenua region, with bores around Levin and Lake Horowhenua indicating nitrate levels of 1-6.5 mg/L and a few in excess of 6.5 mg/L with at least one groundwater bore being above 11.3 mg/L nitrate. The current drinking water standard for nitrate is 11.3 mg/L. One of the bores in the north-east of Levin shows a slight degrading trend in terms of nitrate concentrations.

[24] *Evidence of Gallo Saidy, Group Manager Infrastructure Services at Horowhenua District Council, May 2015.*

- Naturally occurring iron, manganese and arsenic tend to be found in lower concentrations in the Horowhenua and Tararua regions compared to the remainder of the region. In the Horowhenua, median dissolved iron levels are generally less than 1 mg/ L.

In summary, groundwater could provide an alternative source of water, however, there is potential for effects on Lake Horowhenua from increased abstraction. If this option were to be pursued, further investigation of groundwater quantity and, in particular, the interaction with and effect on Lake Horowhenua would need to be fully investigated and assessed. Based on the information available, and noting that the shortfall in water supply required to meet Levin's demands to the 50-year timeframe would require abstraction an order of magnitude greater than the existing groundwater allocation, it is likely that groundwater abstraction to meet the community's needs would have an adverse effect on Lake Horowhenua.

4.1.5 Rainwater Harvesting

The option of rainwater harvesting is considered at a household or property level, to reduce demand on the community water supply[25]. Rainwater harvesting involves properties installing a rainwater collection tank which is connected to the dwelling or building roof area. Rainwater is collected and reused either for non-potable (e.g. outdoor use, garden watering) and / or potable water reuse.

For the purposes of this assessment, it has been assumed that rainwater harvesting will be used for non-potable uses only. A rainwater collection system on an individual property would generally not come under the regulatory control of Taumata Arowai (as it would be considered a domestic self-supply system and would be outside of the scope of the Water Services Act). This notwithstanding, Taumata Arowai has published acceptable solutions for roof water supplies[26] which specify design and installation requirements. Treatment of roof water comprises two-stage cartridge filtration and UV disinfection to ensure that roof water meets drinking water standards. To avoid the need for additional complexity, regulatory oversight, risks of non-potable water being used, and costs to householder, it is assumed that rainwater harvesting would be used for providing water for non-potable uses only.

Rainwater harvesting has the following benefits:

- Collected rainwater reduces the load on stormwater systems and reduces discharges to the shallow groundwater via household soak pits. While this is a benefit in terms of stormwater management, the potential effect on reducing water entering the shallow groundwater and contributing to Lake Horowhenua is unknown.
- The stored water can be used by households to reduce their demand on the community water supply for garden watering, car washing, etc.
- It can increase householder awareness of water availability and potentially assist householders to value water and use water more conservatively during water short periods.
- It provides distributed water storage throughout the community for an emergency household water supply (e.g., in the event of a major earthquake or similar that interrupts the community water supply).

Generally, the costs of installing a rainwater harvesting system is a cost on individual households. Implementation of this option needs to be considered in the context of housing affordability considerations.

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[25] *"Rainwater harvesting" at a community level is assessed under the options of bulk raw water storage and harvesting of supplementary allocation from the river (ie flows above median flow in the River which occur during and after rainfall).*

[26] *Taumata Arowai, October 2022, Drinking Water Acceptable Solutions for Roof Water Supplies.*

Issues that will need to be managed in the implementation of any rainwater harvesting systems include:

- Building consent or similar approvals are likely to be necessary to ensure systems are installed correctly in a way which is isolated from the community drinking water supply and / or has appropriate backflow controls to prevent the risks to the community water supply.
- The benefits of the rainwater storage in reducing demand on the community water supply are limited to the early period of extended dry periods, given that they rely on rainfall to replenish used water. That is, they may assist in reducing average or annual demand, but are unlikely to reduce peak demand on the community water supply.

Horowhenua District Council has already chosen to adopt this option as follows:

- Encouraging the installation of rainwater tanks by providing 200 L tanks at cost to householders in the district. These are promoted as "emergency rainfall tanks" rather than for general use for non-potable water supply.
- Requiring rainwater tanks on new allotments in growth areas. The Proposed Plan Change[27] for the Tara-Ika growth area includes the following provisions:
  - Policy 6A.3.4: "*Require rainwater collection tanks to be provided on all new residential allotments to capture and reuse runoff*"
  - Proposed Rule 15A.6.2.1 Permitted Activity criteria which requires all dwelling to "*have a rainwater collection tank permanently connected to internal and external non-potable reuse including toilet flushing, laundry and outdoor taps*". The Rule states minimum tank sizes of 2,000 to 5,000 litres depending on roof area size. If tanks are not provided, a resource consent will be required for the dwelling (in addition to a building consent).

The proposed rules do provide for dwellings without a rainwater tank to seek consent as a Restricted Discretionary Activity. Of relevance is that the proposed plan change includes the rainwater tanks for stormwater management purposes. The proposed policy which enables the permitted activity criteria requiring rainwater tanks is proposed policy 6A.3.4:

> *"Require rainwater collection tanks to be provided on all new residential allotments to capture and reuse runoff"*

The matters of discretion (i.e. the relevant matters for determining whether or not a consent can be granted for a dwelling without a rainwater tank) are limited to stormwater management considerations. The proposed matters of discretion are (proposed plan change Rule 15A.8.1.1):

> *"(i) The effects on adjacent properties and downstream environments.*
>
> *(ii) The matters set out in Policy 6A.3.1, 6A.3.2 and Policy 6A.3.3".*

The policies referenced above all relate to stormwater management. It would therefore not be legal for the Council to decline land use consent for a dwelling without a rainwater tank from a water supply perspective.

Assuming an average tank size of 3,000 litres (as required for roof areas in the 75-200 m^2 range) across the 3,500 households expected for the Tara-Ika area, the above requirements will result in 10,500 m^3 storage capacity across the development area, once fully developed. This represents less than one day of current peak community demand. This shows that, while rainwater tanks assist to reduce demand on the community water supply, they are not a meaningful contributor to meeting future community needs (i.e., they do not negate, nor delay, the need for an additional water source or bulk storage). They assist in ensuring sustainable use of water and reducing demand but are not, by themselves, a solution to meeting the community's needs.

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[27] *Decision version, adopted by Council 29 June 2022.*

As noted above, rainwater stored on individual properties are expected to be used within the initial stages of an extended dry weather / peak demand period. Therefore, they do not provide meaningful storage to reduce peak community demand. This means that, irrespective of their adoption, the community supply scheme, including treatment plant capacity, will need to meet the projected peak day demand.

Rainwater tanks, if widely adopted, could reduce the overall annual demand on the water supply scheme. If installed across the Tara-Ika growth area as described above, the theoretical maximum reduction in annual water demand is in the order of 470-630,000 m^3 per year, or approximately 10% of the annual demand for the year 2042. This assumes 3,500 houses, with an average contributing roof area of 150-200 m^2 and that all rainfall (average annual rainfall of 900 mm) is captured and used. In reality, a significant proportion of rainfall will be lost (e.g., in wet weather periods where the rainwater tank is full and rainwater overflows) and therefore the contribution of rainwater tanks to meeting future demands is likely to be significantly less than estimated here.

4.1.6 Wastewater Treatment & Re-use

This option would involve treating wastewater at the Levin Wastewater Treatment Plant to a sufficient level that it is suitable for reuse either as potable or non-potable source.

Potable re-use involves treating wastewater to drinking water quality and providing it for re-use (generally through the water reticulation network). While this is technically feasible, there are currently no systems in New Zealand that treat wastewater for direct potable re-use. Watercare is commencing a process to investigate this further as a supply option for Auckland (refer https://www.watercare.co.nz/About-us/News-media/Citizens%E2%80%99-Assembly-recommends-direct-recycled-wate). Wastewater treatment and re-use for drinking water purposes is generally considered unacceptable by mana whenua and by the general community. The potable re-use may be considered a viable option in the future, however, at this stage it is considered that it should not be pursued in recognition of cultural values and community expectations and the timeframes required to progress such an option.

For non-potable re-use, the option would either involve reuse of treated wastewater by large water users who do not need potable water quality and / or reticulation of treated wastewater to households for non-potable uses via a new reticulation network dedicated for this purpose. In terms of large water users, these are typically open spaces such as reserves, parks or golf course irrigation or industrial uses which do not need drinking water quality water. From a water supply perspective, this option only has benefits if these users currently source their water from the community water supply.

For the Levin supply, the large water users are generally involved in the food sector (e.g., Allied Meats). They are unlikely to be able to use water which does not meet drinking water standards. With regards to irrigation water use, the Council's parks and reserves typically source irrigation water from groundwater bores and do not use water from the Levin water supply. The Water Demand Management Plan for the Levin water supply estimates demand from public amenity, parks, gardens, swimming pool uses to be no more than 30 m^3/day. Use of treated wastewater for this purpose would not reduce water demand significantly, and it is therefore not a viable option for water supply purposes[28].

Treated wastewater to a level sufficient for outdoor non-potable use and making this available to the community would require a new reticulation system dedicated to this purpose. If made available to the entire community, this would likely mirror the existing water reticulation network with significant capital and operational costs. Operational and risk management practices would also need to be in place to prevent the treated wastewater being used for potable purposes.

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[28] *Note: this assessment considers the option from a water supply perspective only. It has not assessed whether this is a viable option from a wastewater management perspective.*

4.1.7 Seawater Desalination

This option would involve extraction of seawater and treatment through a desalination process. While the treatment process is proven and has a significant track record in some overseas jurisdictions, it is not used to produce drinking water anywhere within New Zealand. The treatment process requires a significant capital cost, and has significant electricity requirements for operations. Process by-products (brine) require specific consideration.

This option has not been considered further at this stage given the likely significant capital and operating costs, likely long-lead timeframes for implementation, and that this technology is not currently adopted in New Zealand.

4.2 Assessment of Options

To assess the options presented above, a multi-criteria analysis was undertaken, adopting a "traffic light" assessment process and undertaking a qualitative assessment of each criterion. The criteria adopted and the assessment factors are detailed in Table 4.2 below.

Table 4.2: Assessment Criteria

Criteria	Assessment Guidance		
	Green	**Orange**	**Red**
Availability of Water: Is there sufficient water to meet projected needs for Levin?	Sufficient to meet demand to 50 or more years	Meets demand in the 10-50 year range	Does not meet demand in 10 year range
Cultural Values: Ability of the option to meet expectations of mana whenua and to give effect to Te Mana o te Wai.	Considered to give effect to Te Mana o te Wai and may be acceptable.	Contrary to tikanga and Te Ao Maori but may be acceptable with significant mitigations.	Considered to be culturally unacceptable.
Supply Resilience: Does it provide an alternative source of water not subject to the same risks as the Ōhau River source? Does it provide storage for emergency purposes?	Significant improvement in supply resilience.	Improves resilience but some key risks remain.	Does not improve supply resilience.
Environmental: Is there potential for significant adverse effects?	Expected to be able to design and implement option such that effects will be less than minor; potential for enhancements to occur.	Potential for some adverse effects, but these are likely able to be mitigated.	Significant adverse effects likely
Source Water Suitability: Does the option change the risk profile associated with the source water (in terms of obligations for source water risk management under the Water Services Act)	Potential reduction in source water risks.	Similar to existing.	Significance increase in source water risks and / or complexity of source water risk management.
Economics: Capital and Operating Costs relative to other options.	Low costs - similar to existing system.	Options with mid-range of costs, when compared to other options.	Option with the highest capital and operating costs compared to others.

Appendix B contains the assessment matrix for the options against the above criteria and assessment guidelines. It includes commentary as to the traffic light assessment for each criterion of each option assessed. The findings and an overall score and ranking are summarised in Table 4.3. The overall score and ranking have been determined by assuming all criteria have equal weighting and assigning a score of 1 for red; 3 for orange and 5 for green. The option with the highest score is considered the preferred option. Refer to Appendix B for more details of the traffic light assessment for each option.

Table 4.3: Assessment of Options and Overall Ranking. (Assumes all criteria have equal weighting)

	Availability of Water	Cultural Values	Supply Resilience	Environmental Considerations	Source Water Suitability	Economics: Capital and operating costs	Score	Ranking
Bulk Raw Water Storage Using Existing Consented Allocation							22	3
Ohau River Water Harvesting (Reservoir) + Supplementary Allocation							28	1
Other Surface Water Resource: Waikawa Stream							16	5
Other Surface Water Resource: Upper Mangahao							14	8
Other Surface Water Resource: Tokomaru River							14	8
Other Surface Water Resource: Manawatu River							14	8
Groundwater Bores							14	8
Rainwater Harvesting							24	2
Wastewater Treatment & Re-use: Potable Reuse							14	8
Wastewater Treatment & Re-use: Bulk non-potable							16	5
Wastewater Treatment & Re-use: Reticulated non-potable							14	8
Seawater Desalination							16	5

The above assessment has found that:

- The preferred option is water harvesting when the Ōhau River is above median flow (under the Supplementary Allocation provisions of the One Plan) and a Bulk Raw Water Storage Reservoir.
- The second and third ranked options are individual household rainwater harvesting and the Bulk Storage Reservoir by itself. Rainwater harvesting is already being implemented and, while ranked highly, is scored "red" on the ability to meet the future water demand. It therefore can be considered as only part of the overall solution at best. The Bulk Raw Water Storage Reservoir, being ranked third, confirms the criticality of the bulk storage reservoir element of the preferred option.

4.3 Development of Preferred Option - Reservoir Siting

The assessment discussed above identifies that the preferred water supply solution for the Levin community is to construct a large-scale reservoir and seek additional water from the Ōhau River. The following explores this option further to identify a preferred site(s) for the reservoir.

The approach to identifying a preferred site involved a constraints mapping exercise. The following factors were used to identify preferred areas and constraints (i.e., areas which should be avoided in the selection of a potential for the reservoir):

- Sites upstream of the existing intake and Water Treatment Plant are preferrable for the following reasons:
  - Sourcing water for the reservoir further upstream than the existing intake will ensure a similar or better source water quality, will not introduce new source water risks, and will avoid or minimise the need for additional treatment processes.
  - It enables efficient conveyance of stored water from the reservoir to the treatment plant.
- Outstanding Natural Features, Landscape Areas, and Important Ridgelines identified in the District Plan are to be avoided.
- Reference has been made to Cultural Impact Assessments undertaken for the existing consent to identify any culturally significant areas in the vicinity. No areas have been identified but it is noted that the CIA did not specifically consider an off-river reservoir as that was not proposed at the time. The findings of the CIA can therefore be considered indicative only. Engagement with mana whenua is required to confirm the presence or absence of significant sites.
- Known fault lines are to be avoided.
- The reservoir should be sited outside of the active river corridor and floodplain.
- The National Grid Transmission Line corridor is to be avoided.

- Initial concept design indicates a property of at least 40 ha is required to construct a reservoir of sufficient size to meet the demand identified in Section 3. Properties smaller than 40 ha have therefore been excluded.

The constraint mapping is shown in Figure 4.4 below.

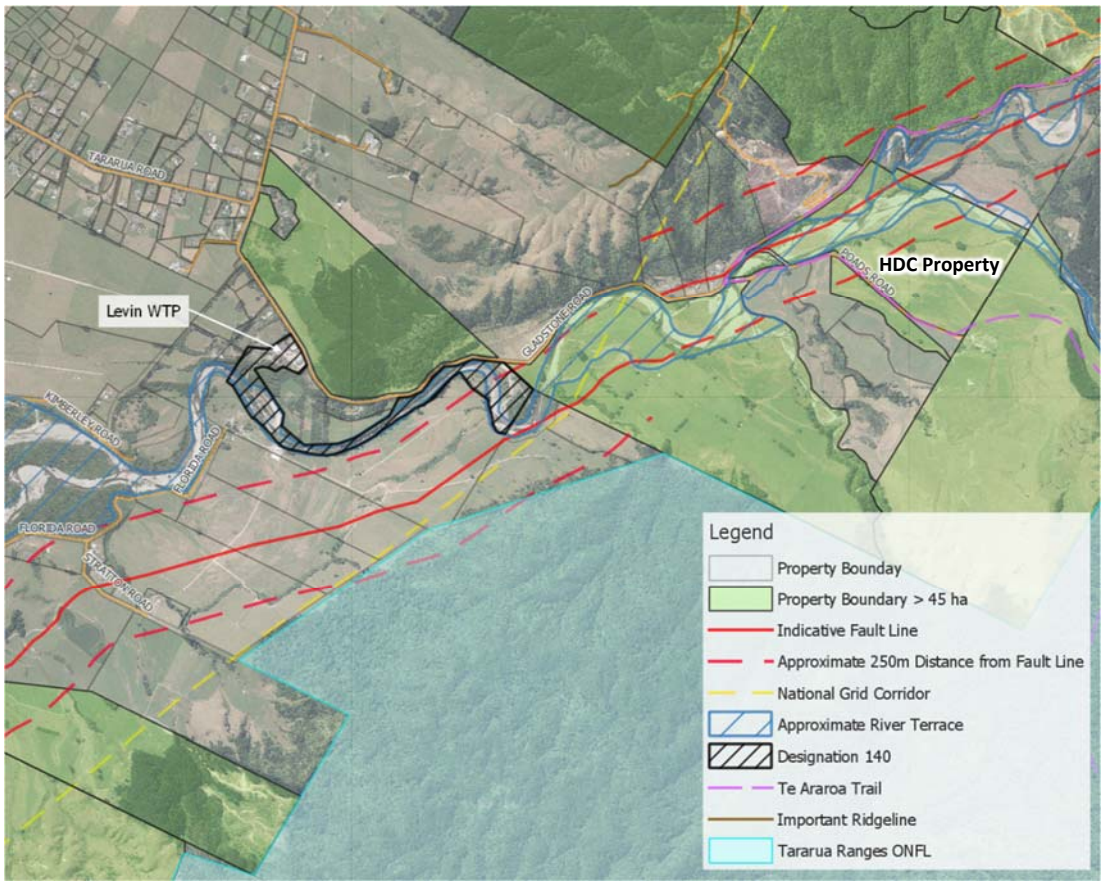


Figure 4.4: Constraint Mapping to Identify Potential Reservoir Sites

Figure 4.4 shows three properties on the northern side of the Ōhau River which are not limited by the above constraints. However, these are not considered preferable because of unsuitable (steep) terrain, forestry cover and presence of watercourses (including that the watercourses flow to the north-east and away from the Ōhau River in some instances). A reservoir on these sites is likely to be difficult to consent and more expensive than other available sites to construct.

There are three potential properties on the southern side of the Ōhau River. The property adjacent to Poads Road (identified as 'HDC Property' on Figure 4.4) became available to the Horowhenua District Council on a willing-seller, willing-buyer property basis (Lot 9 DP 555714). Horowhenua District Council purchased the property for the development of a bulk off-river raw water storage reservoir. Since purchase, further assessment of this site has confirmed that:

- The portion of the site which would be used for the reservoir is under exotic grassland and there are no natural wetland features or areas or rare, threatened or at-risk habitats.
- Geotechnical conditions are suitable for the reservoir construction and on-site materials are suitable in sufficient quantities for construction of the reservoir embankments.
- The site is of sufficient size that a single reservoir of approximately 700,000 m^3 capacity can be constructed.

For the above reasons, the property at Poads Road, Lot 9 DP 55714, is recommended as the preferred site for the water storage reservoir.

5 RECOMMENDED SUPPLY AUGMENTATION OPERATIONAL FRAMEWORK

As set out in Section 4, the preferred option to meet Levin's projected water supply requirement is to construct an off-river, raw water storage reservoir on Council owned property at Poads Road. The reservoir will be filled using a Supplementary Allocation from the Ōhau River. The Supplementary Allocation will be abstracted from the river adjacent to the reservoir. The consenting process to seek the Supplementary Allocation should also consider seeking amendment to the existing consent to allow a portion of the existing core allocation granted to HDC to be abstracted at the new intake. Approval would be subject to this being consistent with the relevant regulatory (RMA) framework and not having significant adverse effects.

To ensure continuity and reliability of water supply, this system should ideally be constructed and operational by 2025. This is the date by which peak demand is predicted to exceed the currently consented allocation from the Ōhau River. This date may be able to be delayed until potentially 2030, depending on the degree of effectiveness of the Council's network pressure management and water leakage management programme.

In addition to the above, the following matters identified in this report must be addressed as part of the overall water supply augmentation framework:

- Giving effect to Te Mana o te Wai
  - The Council is required to undertake its functions as a water supplier under the Water Services Act in a manner that gives effect to Te Mana o te Wai. Engagement with mana whenua is required to determine how Te Mana o te Wai is to be defined in the context of the Levin water supply and how best to give effect to Te Mana o te Wai.
- Source Water Risk Management
  - A Source Water Risk Management Plan is required to be in place for the supply from November 2022.
  - Ongoing implementation of the source water risk management plan is required under the Water Services Act.
- Treatment Plant Capacity & Compliance with Drinking Water Standards
  - The plant is compliant with the Drinking Water Standards in place prior to the end of 2022. These standards have been reviewed and new Quality Assurance rules are introduced by Taumata Arowai. An assessment of the treatment plant is being undertaken against the new rules and quality assurance standards, and any necessary upgrades or modifications identified will need to be implemented.
  - Peak daily demand is projected to exceed the treatment plant capacity between 2025 and 2030. Additional treatment capacity will be required at that time.
- Treated water storage
  - To meet a supply standard of 20 L/person/day for 7-days, strengthening of the existing storage tanks and / or additional treated water storage capacity will be required by 2031.
- Network Management
  - Ongoing implementation of the Council's network management programme including pressure management, leak detection and repair is required and critical for the supply to operate in an efficient manner and meet relevant benchmarks. The provision of additional source water in no way negates the need to manage the supply to minimise leakage, and meets efficiency and reasonable use benchmarks.
  - Annual reporting against the Network Environmental Performance Measures specified by Taumata Arowai is required under the Part 3, Sub-part 8 of the Water Services Act.
- Regional Planning Framework
  - The Regional Council is required to review its Regional Plan and notify a new Regional Plan no later than 31 December 2024. This is likely to involve a review of the water allocation framework and rules affecting water takes. The District Council should ensure that it engages

in this process so that the ability to abstract water to meet the needs of Levin are provided for in the Regional Plan.

The overall augmentation operational framework is summarised in Figure 5.1 below.

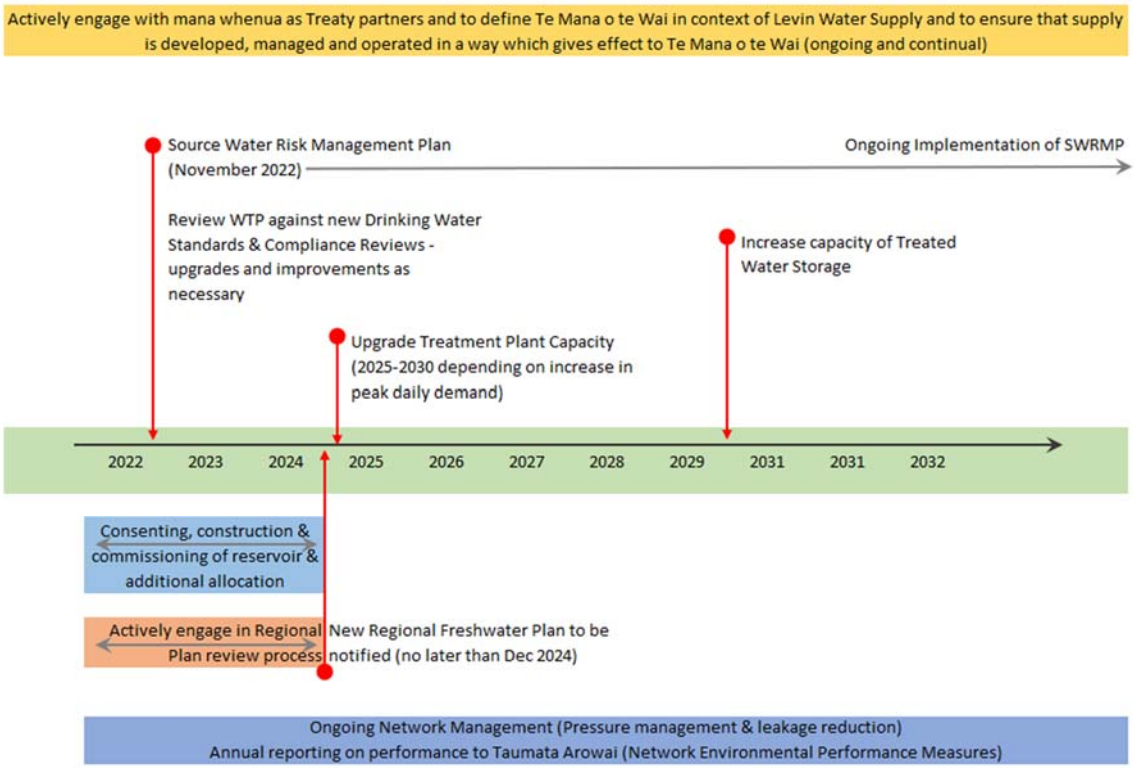
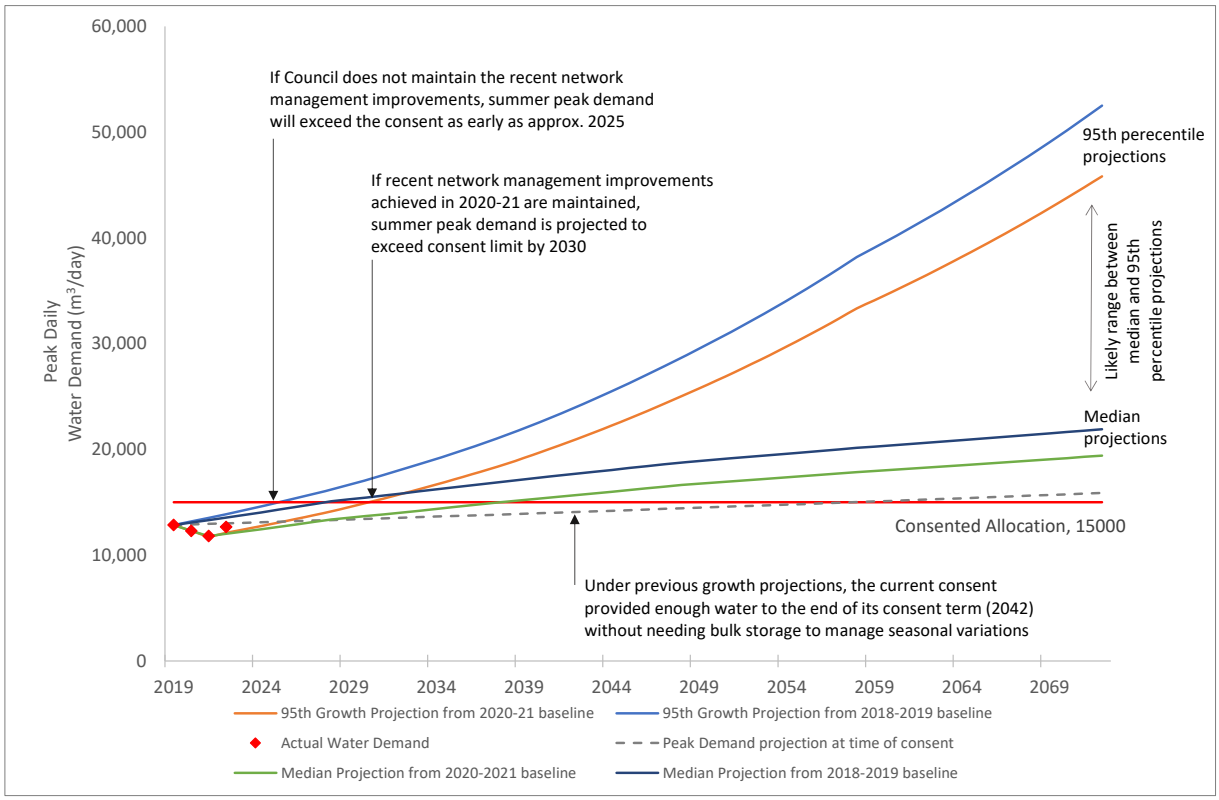


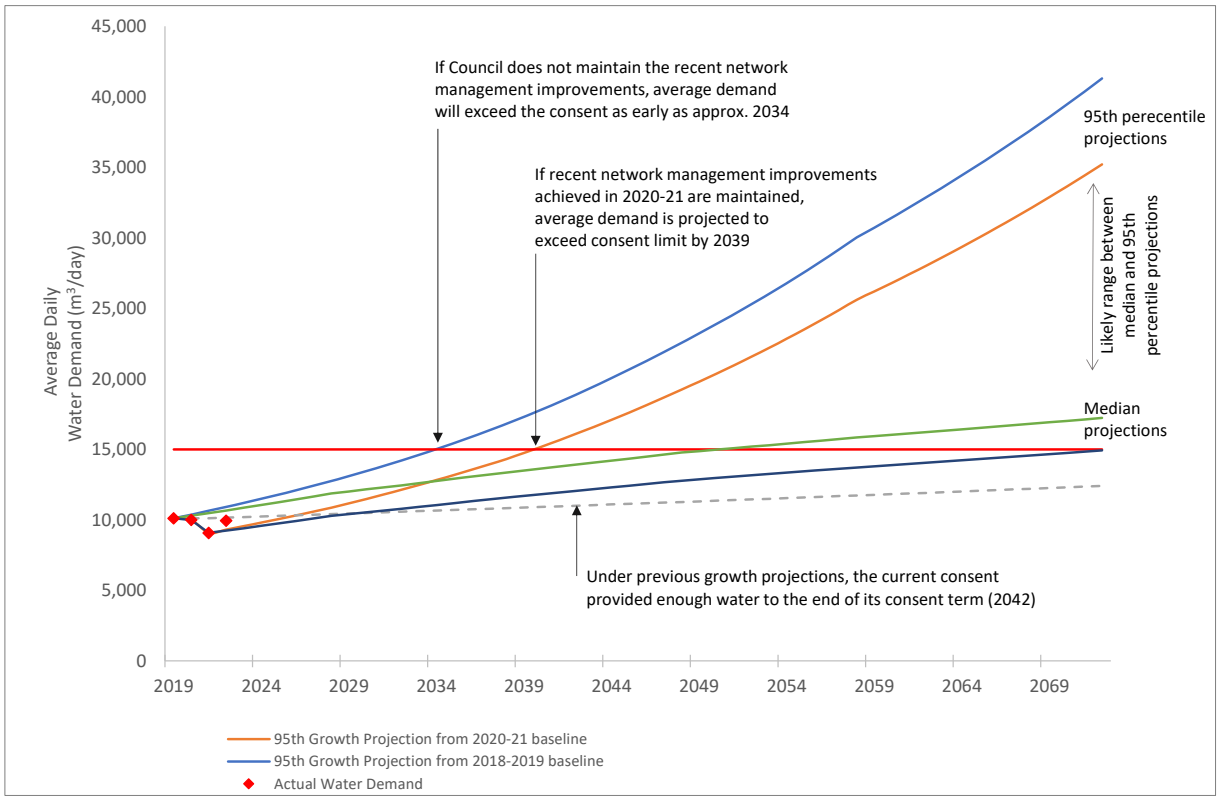
Figure 5.1: Overview of Recommended Water Supply Augmentation Operational Framework

Appendix A

MEDIAN GROWTH WATER DEMAND PROJECTIONS

Levin Water Supply: Sensitivity Analysis of Demand Projections Comparing 95th Percentile and Median Growth Projections





Appendix B

MULTI-CRITERIA ANALYSIS OF OPTIONS

Levin Water Supply Augmentation Operational Framework - Assessment of Alternatives

	Availability of Water	Cultural Values	Supply Resilience	Environmental Considerations	Source Water Suitability	Economics: Capital and operating costs
	Is there sufficient water to meet the projected future needs for Levin?	**Ability to meet expectations of mana whenua; option provides for Te Mana o te Wai**	**Does it provide an alternative source of water not subject to the same risks as the Ohau River source? Does it provide storage for emergency purposes.**	**Are there potential for significant adverse effects?**	**Does the option change the risk profile associated with the source water (in terms of obligations for source water risk management under the Water Services Act)**	**What is the relative costs of each option**
	Provides only short term solution (<10 years)	Considered to be culturally offensive, and unacceptable	Does not improve supply resilience	Significant adverse effects likely	Significance increase in source water risks and / or complexity of source water risk management	Option with the highest capital and operating costs compared to others.
	Meets demand in the 10-50 year range	Contrary to tikanga and Te Ao Maori but may be acceptable with significant mitigations	Improves resilience to a degree, but some key risks remain	Potential for some adverse effects, but these are likely able to be mitigated.	Similar to existing	Options with mid-range of costs, when compared to other options
	Sufficient to meet demand for next 50 years	Considered to be consistent with Te Mana o te Wai and may be acceptable	Significant improvement in supply resilience;	Expected to be able to design and implement option such that effects will be less than minor; potential for enhancements to occur.	Potential reduction in source water risks	Low costs - similar to existing system
Bulk Raw Water Storage Using Existing Consented Allocation	Without additional water allocation, storage only bridges the gap between the peak day and average day demand. Annual demand is projected to exceed existing consent by 2030-2036 (depending on the degree to which exercise of the existing consent is constrained by minimum or high flows in the river). Therefore bulk storage only provides sufficient water to meet demand until this time (approx 10-years).	Does not involve additional abstraction of water; depends on cultural values / significance of site and ensuring mana of source water is protected during storage phase.	Large source of stored raw water available to meet community demands in an emergency (subject to design to appropriate seismic resilience standards)	Works largely undertaken off-river; subject to site selection that avoids areas of significant habitat or cultural value; Standard best practice construction management techniques to be used to manage construction effects.	Reduces reliance on the need to abstract water from the River during high turbidity periods in the short term	New reservoir construction and operation. Concept level costs estimates are $6-11million
Ohau River Water Harvesting (Reservoir) + Supplementary Allocation	Supplementary allocation available meets 50-year demand projections, and potentially provides longer timeframe demand depending on high flow river cut-off adopted to avoid abstraction of high turbidity water and effectiveness of demand management measures	Additional abstraction from river is above median flow - provides for water to go to the river as first priority; enables Council to reduce its abstraction at times of minimum flow; depends on cultural values / significance of site and ensuring mana of source water is protected during storage phase.	Large source of stored raw water available to meet community demands in an emergency (subject to design to appropriate seismic resilience standards)	Provides ability for Council to reduce its abstraction when the River is below minimum flow. Reservoir expected to have less than minor effects subject to site selection that avoids areas of significant habitat or cultural value; Standard best practice construction management techniques to be used to manage construction effects Effects of abstraction expected to be less than minor subject to being within One Plan allocation framework; assumes sub surface intake to provide for fish passage and intake site selection to avoid areas of rare, threatened or at risk habitat.	Reduces reliance on the need to abstract water from the River during high turbidity periods. Ability to abstract water from higher up the river catchment - if abstraction is from the upper Ohau above the confluence with the Makakahi Stream, abstraction can be from area which is predominantly in conservation estate. Influence of forestry land uses in Makakahi catchment can be reduced.	New reservoir construction and operation. Concept level costs estimates are $6-11million
Other Surface Water Resource: Waikawa Stream	Approximately 4,000 m3/day available in core allocation. Provides sufficient water to meet demand when combined with the Ohau River allocation and storage	Involves transfer of water from one catchment to another. Unlikely to be acceptable	Alternative surface water source available. Likely to be restricted at times of minimum flow during similar periods to Ohau River (in case of region wide drought); likely subject to similar climate change risks re drought occurrence.	Only enables Council to reduce its abstraction from the Ohau River and Waikawa if it is combined with storage. New intake on Walkaway Stream required. Effects of abstraction expected to be less than minor subject to being within One Plan allocation framework, assumes sub-surface intake to provide for fish passage and intake site selection to avoid areas of rare, threatened or at risk habitat. Significant disturbance in new pipework from Waikawa Stream to Levin - careful route selection required to avoid areas of significance.	Unknown, but likely to be similar to existing source in Ohau River, depending on where the intake site is located (potential to locate close to exit of water course from conservation estate)	New intake on Waikawa Stream plus approximately 15-20km or more of supply pipeline. Potentially new treatment plant to be installed
Other Surface Water Resource: Upper Mangahao	Approximately 5,000 m3/day available in core allocation. Provides sufficient water to meet demand when combined with the Ohau River allocation and storage	Involves transfer of water from one catchment to another, as well as transfer from eastern side of Tararua Ranges to western side of Ranges. Unlikely to be acceptable	Alternative surface water source available. Likely to be restricted at times of minimum flow during similar periods to Ohau River (in case of region wide drought); likely subject to similar climate change risks re drought occurrence.	Only enables Council to reduce its abstraction from the Ohau River and Mangahao if it is combined with storage. New intake on Mangahao required and significant infrastructure (pipeline) required through conservation estate land - likely to be significant habitat disturbance. Effects of abstraction expected to be less than minor subject to being within One Plan allocation framework, assumes sub-surface intake to provide for fish passage and intake site selection to avoid areas of rare, threatened or at risk habitat.	Unknown, but likely to be similar to existing source in Ohau River or better given source in conservation estate	New intake on Mangahao Stream involving construction and pipeline through conservation estate in difficult terrain. Potentially new treatment plant to be installed
Other Surface Water Resource: Tokomaru River	Approximately 6,000 m3/day available in core allocation. Provides sufficient water to meet demand when combined with the Ohau River allocation and storage	Involves transfer of water from one catchment to another. Unlikely to be acceptable	Alternative surface water source available. Likely to be restricted at times of minimum flow during similar periods to Ohau River (in case of region wide drought); likely subject to similar climate change risks re drought occurrence. Some additional resilience provided given major source entering network from northern side of town.	Only enables Council to reduce its abstraction from the Ohau River and Tokomaru if it is combined with storage. New intake on Tokomaru River likely required. Effects of abstraction expected to be less than minor subject to being within One Plan allocation framework, assumes sub-surface intake to provide for fish passage and intake site selection to avoid areas of rare, threatened or at risk habitat. Significant disturbance in new pipework from Tokomaru to Levin - careful route selection required to avoid areas of significance.	Similar to existing	New intake on Tokomaru River plus approximately 30km or more of supply pipeline. Potentially new treatment plant to be installed, particularly given that route would enter network via north (opposite side from existing treatment plant)

Levin Water Supply Augmentation Operational Framework - Assessment of Alternatives

	Availability of Water	**Cultural Values**	**Supply Resilience**	**Environmental Considerations**	**Source Water Suitability**	**Economics: Capital and operating costs**
	Is there sufficient water to meet the projected future needs for Levin?	**Ability to meet expectations of mana whenua; option provides for Te Mana o te Wai**	**Does it provide an alternative source of water not subject to the same risks as the Ohau River source? Does it provide storage for emergency purposes.**	**Are there potential for significant adverse effects?**	**Does the option change the risk profile associated with the source water (in terms of obligations for source water risk management under the Water Services Act)**	**What is the relative costs of each option**
	Provides only short term solution (<10 years)	Considered to be culturally offensive, and unacceptable	Does not improve supply resilience	Significant adverse effects likely	Significance increase in source water risks and / or complexity of source water risk management	Option with the highest capital and operating costs compared to others.
	Meets demand in the 10-50 year range	Contrary to tikanga and Te Ao Maori but may be acceptable with significant mitigations	Improves resilience to a degree, but some key risks remain	Potential for some adverse effects, but these are likely able to be mitigated.	Similar to existing	Options with mid-range of costs, when compared to other options
	Sufficient to meet demand for next 50 years	Considered to be consistent with Te Mana o te Wai and may be acceptable	Significant improvement in supply resilience;	Expected to be able to design and implement option such that effects will be less than minor; potential for enhancements to occur.	Potential reduction in source water risks	Low costs - similar to existing system
Other Surface Water Resource: Manawatu River	Available Core allocation is 7 times the 50-year peak day water demand projection. Could provide sufficient water without need for storage, however this would need an abstraction from the Manawatu River at minimum flow.	Involves transfer of water from one catchment to another. Unlikely to be acceptable	Alternative surface water source available. Likely to be restricted at times of minimum flow during similar periods to Ohau River (in case of region wide drought); likely subject to similar climate change risks re drought occurrence.	Does not enable Council to reduce its abstraction from the Ohau River or Manawatu River at times of minimum flow unless storage also provided. New intake from Manawatu River. Effects of abstraction expected to be less than minor subject to being within One Plan allocation framework, assumes sub-surface intake to provide for fish passage and intake site selection to avoid areas of rare, threatened or at risk habitat. Significant disturbance in new pipework from Manawatu River to Levin - careful route selection required to avoid areas of significance.	Extremely large catchment with complexity of land uses and large number of potential source water risk. LAWA database indicates poor water quality with degrading trend.	New intake on Manawatu River plus approximately 30 km of supply pipeline. New treatment plant and / or new treatment processes to be installed as poorer source water quality than Ohau River source (eg nutrient removal)
Groundwater Bores	While the Regional Plan allocation framework suggests there is sufficient water to meet 50-year demand, existing groundwater abstraction has been found to have a potential adverse effect on Lake Horowhenua and science based assessments for Horizons have recommended no further allocation. Existing allocation is only 10% of the water required to meet Levin's 50-year needs and therefore sourcing this water from groundwater would be considered to have significant adverse effects on the Lake based on current knowledge.	Unlikely to be acceptable given likely effects on Lake Horowhenua	Groundwater resource typically not affected by drought; Provides alternative sources within the supply area so vulnerability to loss of trunk main supply pipes reduced; source within supply area can provide untreated water collection points in emergency; bore condition can be compromised in earthquake resulting in source water risks.	Likely to be significant adverse effects in terms of reduction of groundwater inflow to Lake Horowhenua	New water source which would require full assessment of source water risks and different risk management approach compared to existing surface water source.	Bore construction and groundwater treatment. No significant conveyance required. Costs estimated at $11-19 million in 2015.
Rainwater Harvesting	Rainwater harvesting can only provide for a portion of non-potable use. Estimated storage to be installed via new District Plan rules equates to one day current peak demand and relies on rainfall patterns for availability. Provides <10% of projected annual demand.	Rainwater harvesting provides for an alternative source of water this is able to be used without adverse effect on the environment. As per District Plan policy, it seeks to mimic pre-development hydrologic conditions.	Provides for short-duration emergency household supply (i.e. 3-5 days supply for each house). Does not improve resilience to extended drought conditions.	Can be implemented at property level, so no large scale infrastructure; reduces stormwater effects of development.	Water is not used for potable sources - does not need to be considered within Source Water Risk Management framework of the Water Services Act.	Cost incurred at household level.
Wastewater Treatment & Re-use: Potable Reuse	Full closed loop potable reuse would only provide water which is captured in the wastewater network. Drinking water used outside is not captured, and therefore reuse cannot provide for 100% of water demand.	Reuse of wastewater for drinking water purposes is considered culturally offensive.	Provides for re-use of water only - does not provide storage in event of source water shortages, nor does it provide water from an alternate source such that the supply is less susceptible to drought conditions (re-use of water will slow, but not remove, effects of drought conditions)	Potentially significantly reduces effects of wastewater discharge	New Source water is treated human effluent - significant source water risks to be managed.	Significant additional wastewater treatment costs to treat to drinking water standards. Potentially offset against future savings in wastewater budget (i.e. wastewater treatment improvement costs likely to be incurred in future regardless of this option from a water supply perspective)
Wastewater Treatment & Re-use: Bulk non-potable	Bulk water users who could accept non-potable water quality are < 1% of the community water demand. Providing treated wastewater for non-potable re-use does not reduce projected water demand	May be acceptable depending on re-use. Reduces effects of wastewater discharge.		Unlikely to be adverse effects, but does not create a significant reduction in quantity of wastewater for disposal (i.e. no real reduction in effects of wastewater treatment).	Dedicated supply to a few non-potable water uses. Does not require new source water risks to be assessed or managed.	Potentially significant additional wastewater treatment costs to treat to appropriate standards. Potentially offset against future savings in wastewater budget (i.e. wastewater treatment improvement costs likely to be incurred in future regardless of this option from a water supply perspective). Depending on location of re-use may or may not be significant conveyance costs.
Wastewater Treatment & Re-use: Reticulated non-potable	Reticulated non-potable water re-use could reduce demand on drinking water supply to drinking water needs only. Assuming 250-300 L/person/day is to be supplied from the water supply (i.e. not from the reuse system), 50-year water demand is 18,000-22,500 m3/day which exceeds current consented limit	May be acceptable depending on re-use. Reduces effects of wastewater discharge.		Potentially significantly reduces effects of wastewater discharge	Potential cross-connection between potable and non-potable reticulation networks requires management throughout life of assets	Significant additional wastewater treatment costs to treat to appropriate standards. Potentially offset against future savings in wastewater budget (i.e. wastewater treatment improvement costs likely to be incurred in future regardless of this option from a water supply perspective). Significant additional costs in duplicate reticulation network (capital, operations, renewals)
Seawater Desalination	Seawater is considered to be available in sufficient quantities to meet projected demand.	Unknown	Significant alternative source not susceptible to drought conditions. Desalination processes have high energy demands and therefore potential vulnerability to power outages, but this can be addressed through provision of back up supplies if considered necessary.	Unknown. Potential carbon footprint concerns depending on electricity source to power the treatment plant.	Unknown	Significant treatment costs (capital and operational) expected, plus 10-15 km of supply pipeline. New technology for NZ - capacity and capability to construct and operate plant would need to be considered.

Appendix C

ŌHAU RIVER SUPPLEMENTARY WATER ASSESSMENT

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To	**Daniel Bardsley**	*From*	**Alasdair Keane**
	Damwatch Engineering	*Date*	**24th November 2021**
	Level 3, 88 The Terrace	*Reference no.*	**P21X**
	Wellington 6140		

Gladstone Reservoir - high level assessment of flow volume available in Ohau River.

Executive Summary

Horowhenua District Council (HDC) is investigating the development of off-river storage to improve the reliability of municipal water supply at Levin.

Operation of the Levin Water Treatment Plant (WTP) is constrained when raw water turbidity reaches 10 NTU and the plant is stopped when turbidity reaches 20 NTU. Storage of low turbidity river flow in an off-river reservoir could allow uninterrupted operation during periods of high river turbidity.

Damwatch Engineering (DWE) are undertaking a feasibility assessment for an off- river raw water storage reservoir on land owned by HDC on Poads Road, adjacent to the confluence of the Makahika Stream and the Ohau River (see Figure 1). The proposed storage pond (Gladstone Reservoir) is expected to have a storage capacity of 600,000 to 700,000m^3 (to be confirmed).

The scope of this report is to make a high level estimate of

- the remaining flow available in the Core Allocation in the Ohau River,
- the additional volume available in a Supplementary Allocation,
- the effect of additional abstraction on downstream flows.

Hydrological records have been obtained from Horizons Regional Council and Horowhenua District Council. These include

- Ohau River at Rongomatane flow record,
- Raw water turbidity record at the Levin Water Treatment Plant,
- Concurrent flow and suspended sediment concentration measurements on the Ohau River and Makahika Stream at their confluence, and at Rongomatane,

The key flow statistics for the Ohau River at Rongomatane are shown in Table E1.

	Flow (m^3/s)
	Jul-1979 to Jun-2021
Mean	6.460
Median [1]	3.809
3 x median [2]	11.430
5 x median flow [3]	19.045
MALF [4]	1.174
Minimum flow [5]	0.820

Table E1 Selected flow statistics for the Ohau River at Rongomatane.

[1] Median flow is the flow equalled or exceeded 50% of the time over the period of analysis.

[2] 3 x median flow is an index flow to indicate biological disturbance. FRE_3 is the annual frequency of these flushing flows.

[3] 5 x median flow has been used as an arbitrary threshold to indicate highly sediment laden water.

[4] MALF is mean annual 7 day low flow.

[5] Minimum flow is the base of the Core Allocation, below which general abstraction ceases.

The existing Core Allocation and remaining volume in the Ohau River is shown in Table E2.

Annual volumes for the remaining Core Allocation and a Supplementary Allocation based on 10% of the flow above median flow have been calculated for an average year using the flow duration curve for the period 1 Jul 1979 to 30 Jun 2021.

The remaining Core Allocation could fill the proposed reservoir volume twice in an average year. An analysis for drier years has not been undertaken but may show that some volume from a Supplementary Allocation may be needed in these years.

	Consented Volume m^3/day	Average Annual Volume 1 Jul 1979 to 30 Jun 2021 (m^3/year)	Volume excl. flow > 5x median flow (m^3/year)
Core Allocation	24,192		
Existing Consents	20,628		
Remaining Core Allocation	3564	1,257,000	1,194,000
A Supplementary Allocation (10% flow > median flow)		22,622,000	10,648,000
Total		23,879,000	11,842,000

Table E2 Potential flow allocation volume in the Ohau River catchment.

Excluding highly sediment laden or turbid flow from storage would result in a 5% reduction in the volume available from the remaining Core Allocation and a 53% reduction in the flow available from a Supplementary Allocation. This is still many times larger than the proposed reservoir.

A qualitative assessment of the downstream effect on minimum flow, median flow and flushing flows (FRE_3) from abstracting the remaining Core Allocation volume into off-river storage is small. The effects of a Supplementary Allocation are also small, with the most significant effect being a potential 10% reduction in the magnitude of flushing flow events but the effect on the FRE_3 statistic (the frequency of flushing flows) would be small.

Actual volumes stored will depend on the location and design of the reservoir and its intake arrangement (to be confirmed).

Some assumptions have been made about the flow available for storage at the Makahika confluence. The available raw water NTU and river flow data are poorly correlated, even allowing up to 1 hour lag for flow travel time. Additional river turbidity data at Rongomatane and upstream of the Makahika confluence is needed to better understand the source area and relationship between turbidity and flow at a reservoir intake. This could also provide early warning of high turbidity events for current plant operation.

Analysis of flow gaugings shows a significant proportion of the Ohau River flow is lost to the underlying geology between the Makahika confluence and Rongomatane below the minimum flow at Rongomatane. Above this the flow at the Makahika confluence and Rongomatane is roughly the same, although this is based on only two flow gaugings and more information is needed be confident. About 40% of the flow is from the Ohau River upstream of the confluence. The interaction between surface water and groundwater systems downstream form the confluence is likely complex and dynamic.

The key recommendations are

- Collect additional flow and turbidity data this summer
  a) concurrent flow gaugings at Makahika confluence and Rongomatane above minimum flow
  b) turbidity sensor at locations upstream and downstream of Makahika confluence to identify origin and character of high turbidity flow events
- Undertake more detailed hydrological assessment including
  a) revise flow volume available above minimum flow
  b) derive objective correlation between turbidity and flow or rainfall at the Makahika confluence
  c) the availability of river flow volume in drier years
  d) access the impact of predicted future climate change and supply demand growth
  e) optimise the reservoir volume and intake location
  f) update the assessment of effects

Introduction

Horowhenua District Council (HDC) is investigating the development of off-river storage to improve the reliability of municipal water supply at Levin. The Levin water treatment plant (WTP) was upgraded in 2017 and is consented to take up to 15,000m^3/day from the Ohau River [6].

The plant operating guideline [7] states flow through the water treatment plant is reduced to minimum (300m^3/d) when raw water turbidity increases above 10 Nephelometric Turbidity Unit (NTU) and the plant is stopped when raw water turbidity reaches 20 NTU. Filter backwashing associated with these events adds additional downtime.

Damwatch Engineering (DWE) are undertaking a feasibility assessment for an off- river raw water storage reservoir on land owned by HDC on Poads Road, adjacent to the confluence of the Makahika Stream and the Ohau River (Figure1). The proposed storage pond (Gladstone Reservoir) is expected to have a storage capacity of 600,000 to 700,000m^3 (to be confirmed).

The scope for this high level assessment is;

a) assemble available hydrological information
b) estimate the additional flow volume available in the Ohau River (One Plan),
c) provide qualitative comments on the likely effect of downstream flows from additional abstraction to fill Gladstone Reservoir,

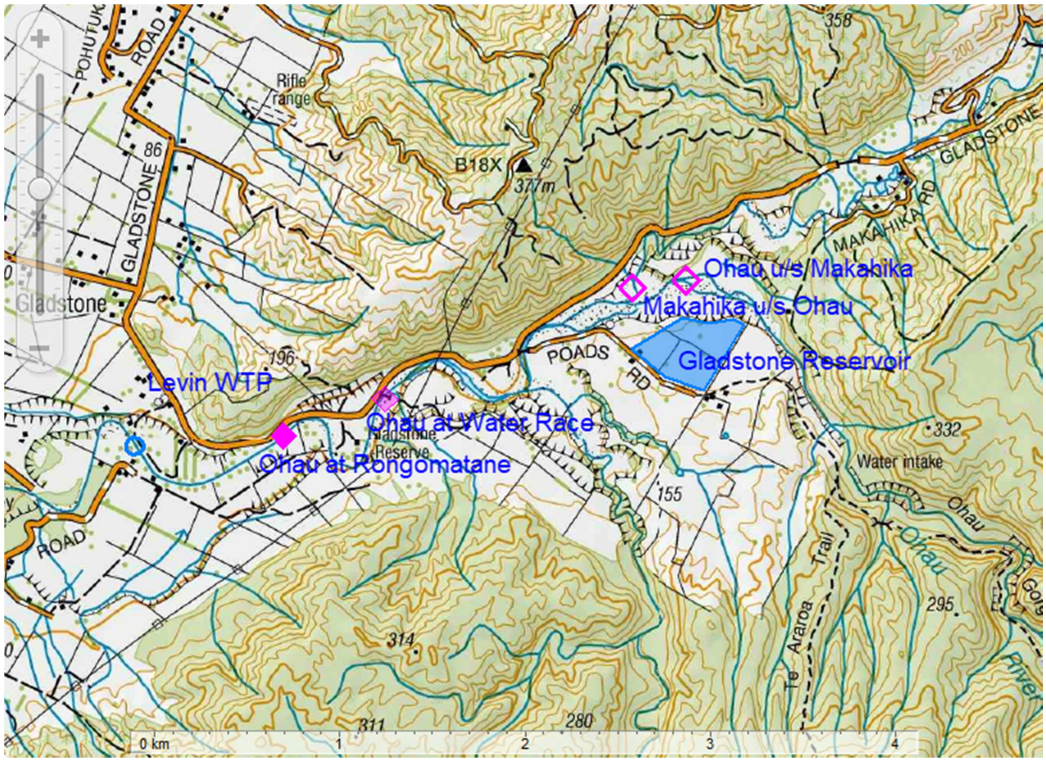


Figure 1 Location of measurement sites in relation to the WTP and Gladstone Reservoir site

[6] Consent Order dated 15th May 2017 issued by Environment Court Judge B P Dwyer, Environment Court Wellington.
[7] HDC (2018) Levin WTP – Operating Guidelines February 2018.

Hydrological Information

Flow records for the Ohau River upstream of the treatment plant are available from January 1974 (Table 1). The current site at Rongomatane is operated by Horizons Regional Council (HRC) and is used to regulate surface water takes. The flow record is well supported by regular flow gaugings and can be considered reliable.

The Rongomatane site is located downstream of the previous water race intake to the water treatment plant. River flow recorded prior to commissioning the current river intake in 2017 does not include water diverted to the treatment plant, or discharged back to the river downstream of the recorder. The missing flow is variable and a function of river flow and supply demand. It is assumed to be in the order 0 to 0.25 m^3/s and does not significantly affect the results of this analysis.

Concurrent flow gaugings have been carried out by HRC at Rongomatane and various other locations on the river (Table 1) including on the Makahika Stream and Ohau River at their confluence (Figure 1). Almost all the flow gaugings are at flows below the minimum flow at Rongomatane (0.82m^3/s) and only one is above this flow.

Site name	Catchment area (km^2)	Map reference NZMG	Records
Ohau R. at Water Race	104	2707730 6057950	Digitised chart water level recorder data from 18/1/1974 to 15/7/1978, 374 flow gaugings between 0.539 and 247.8m^3/s, 14 flow rating changes & SSC rating 2 SSC gaugings
Ohau R at Rongomatane	105	2707180 6057750	Digital water level data from 14/7/1978 to 4/5/2021, 137 flow gaugings between 0.923 and 129.2m^3/s, 95 flow ratings changes, 9 SSC gaugings
Ohua R u/s Makahika	36.5	2709600 6058600	22 flow gaugings, 16 gaugings concurrent with Rongomatane 1 SSC grab samples
Makahika Str u/s Ohau	40.6	2708800 6058500	51 flow gaugings, 26 concurrent with Rongomatane 1 SSC grab sample
Ohau at Gladstone Reserve			100 SSC grab samples

Table 1 Selected hydrological data used for this study.

Sediment data available on the Ohau River is limited (Table 2) mainly comprising suspended sediment grab samples provide indicative analyses only of suspended sediment concentration (SSC). NIWA have derived a suspended sediment concentration vs flow rating based on integrated suspended sediment gaugings.

Location	No samples	Range (mg/L)
Ohau at u/s Makahika Confluence	17	1
Makahika Above Ohau Confluence	1	1-3
Ohau at Gladstone Reserve	100	1-5
Ohau at Haines Property	105	0-699
Ohau at State Highway Bridge	17	0-826

Table 2 Summary of suspended sediment grab samples collected by HRC on the Ohau River.

HDC logs a wide array of process data on the WTP Scada including river flow and the turbidity of raw water pumped from the river. The raw water turbidity data begins in June 2017 and is logged at 1 minute intervals.

Access to and use of data provided by HRC and HDC for this flow assessment is acknowledged.

River Flow Statistics

The flow statistics for the Ohau River at Rongomatane from the time the current water allocation in One Plan was set are summarised in NIWA (2007)[8].

Selected flow statistics are summarised in Table 3 and are compared with statistics for the longer period up to the present. The mean flow is slightly higher and MALF is significantly higher.

	Flow (m^3/s)		Change (%)
	Jul-1979 to Jun-2004 (from NIWA 2007)	Jul-1979 to Jun-2021	
Mean	6.399	6.460	1
Median	3.819	3.809	-0.3
3 x median	11.457	11.430	
5 x median flow		19.045	
MALF[9]	1.042	1.174	12.7

Table 3 Selected river flow statistics for Ohau River at Rongomatane

Current Flow Allocation

Regulation of resource consents in the Ohau catchment is based on flows measured at the Rongomatane gauge. The existing allocation of flows in the Ohau River catchment is shown in Table 4.

The Core Allocation for the Ohau River is 24,192m^3/d (Whole Zone, Ohau_1, in Table C1) [10]. Existing consents, including the Levin WTP, amount to 20,628m^3/d [11]. The remaining volume in the Core Allocation is therefore 3,564m^3/d.

	Consented Volume m^3/day	Average Annual Volume 1 Jul 1979 to 30 Jun 2021 (m^3/year)
Core Allocation	24,192	8,663,000
Existing Consents	20,628	7,404,000
Remaining Core Allocation	3,564	1,257,000

Table 4 Existing Allocation of flow in the Ohau River catchment

Annual volumes in Table 4 have been calculated for the Jul-1979 to Jun-2021 period by converting the daily volume to a flow rate and integrating this in terms of area under the flow duration curve in Figure 2. The annual volume presented in Table 4 is not the consented volume multiplied by 365

[8] NIWA (2007) Statistical analysis of river flow data in the Horizons Region, NIWA Client Report CHC2006-154, May 2007 https://www.horizons.govt.nz/HRC/media/Media/One%20Plan%20Documents/Statistical-analysis-of-river_ta-in-the-Horizons-Region.pdf?ext=.pdf

[9] MALF is mean annual 7 day low flow

[10] Horizons Regional Council (2014) One Plan, https://www.horizons.govt.nz/data/one-plan.

[11] Horizons Regional Council's Water Matters web-site portal accessed on 19/10/21 reports the existing allocation for the Ohau River on 19/10/21 is 20,628m^3/d.

days. It is a lower volume that accounts for periods when the consented volume is not actually available to be abstracted from the river when flows are low.

The Levin WTP consent allows a reduced take when river flow is below the minimum flow ($0.82m^3/s$). This is included in the Core Allocation volume above the minimum flow.

The Core Allocation volume is illustrated in Figure 2 by the area under the flow duration curve between the minimum flow and the solid red line.

In an average year the remaining Core Allocation volume could fill the proposed reservoir volume twice, however in dryer years fully filling an already depleted storage is less likely and during sequences of years with drier than average river flows. A more detailed analysis of the seasonality of droughts and dry year reliability of the storage should be undertaken. A sensitivity analysis using the driest year 1993-94 could also give an indication of dry year reliability.

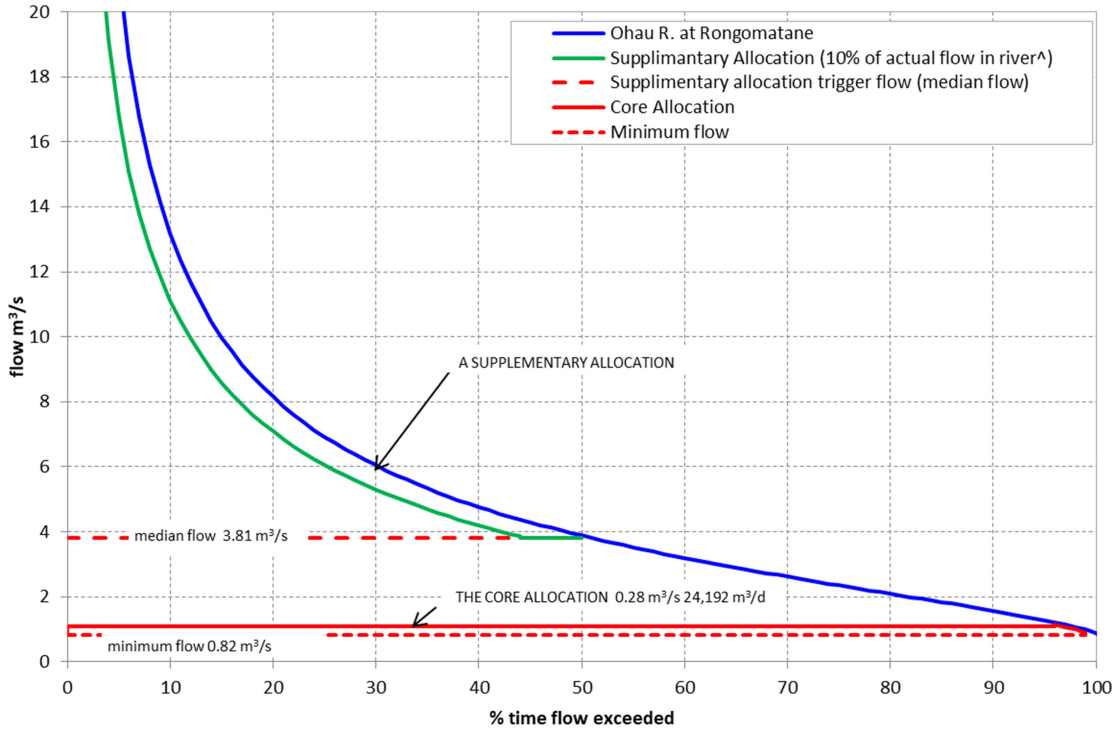


Figure 2 The flow duration curve for the Ohau River at Rongomatane (1 Jul 1979 to 30 Jun 2021) illustrating the Core Allocation above minimum flow and a Supplementary Allocation above median flow.

A Supplementary Allocation Volume

One Plan allows for the creation of a Supplementary Allocation in Policy 5-17. This applies where water is only taken when the river^ [12] is above median flow. The total amount of the Supplementary Allocation must not exceed 10% of the actual flow in the river^ at the time of abstraction and it can only be allocated where the activity does not result in significant adverse effects including increasing the duration of minimum flows or leading to a significant departure from the natural flow regime.

[12] River^ refers to the river measured at the regulating measurement site. In this case flow at the Ohau at Rongomatane flow gauge.

The median flow at Rongomatane is 3.81m^3/s (1 Jul 1979 to 30 Jun 2021). Assuming 10% of the actual flow above median flow and integrating the area represented by this flow under the flow duration curve in Figure 2, an average annual Supplementary Allocation volume would amount to 22,622,000m^3. This far exceeds the requirement for the Gladstone Reservoir storage volume.

This volume is represented by the area above the green line in Figure 2. This volume includes periods when river turbidity is elevated and it may be desirable to exclude this water from storage.

Flow Available at Proposed Gladstone Reservoir Site

Concurrent flow measurements at Rongomatane and the Makahika confluence show that when flow is below the minimum flow, the Ohau River loses a significant proportion of its flow to the underlying geology (the black line in Figure 3).

When flow is above the minimum flow, the flow loss appears much less. The flow at the Makahika confluence is about 0.23m^3/s higher when Rongomatane is at the minimum flow and about 0.27m^3/s higher at median flow. This interpretation is based on minimal information, two concurrent flow gaugings and a line drawn through them (the blue line in Figure 3). These flow gaugings were carried out prior to the commissioning of current intake, so flow at Rongomatane does not include flow diverted at the previous water race intake upstream. If gauged again today the Rongomatane flows would have been similar or slightly higher than at the Makahika confluence.

Concurrent flow gaugings in the Ohau River upstream of the Makahika confluence indicate the Ohau flow is about 40% of the flow measured at Rongomatane.

It is assumed for now that in the Core Allocation flow range (0.82 to 1.1m^3/s) and for flow above the median flow (3.81m^3/s) that the flow at the Makahika confluence is roughly equivalent to the flow measured at Rongomatane downstream.

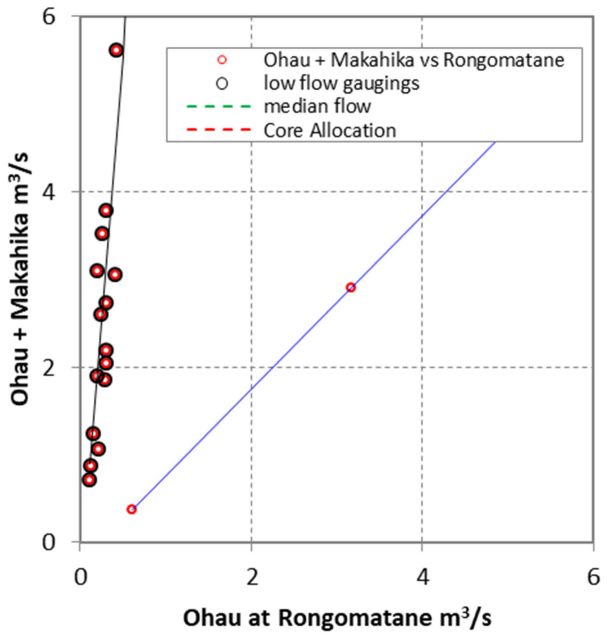


Figure 3 Correlations between flow gaugings at Rongomatane and the combined gauged flow at Makahika confluence (left) and on Ohau upstream from the confluence (right).

The interaction between surface water in the Ohau River and the groundwater as the river exits the hills is likely complex and dynamic.

Additional concurrent flow measurements are needed at flows above the minimum flow to define the relationship with greater confidence.

Six additional concurrent flow measurements over the flow range 0.8 to 3.5m^3/s would significantly improve confidence in the relationship above minimum flow. A start should be made to collect these measurements when flow conditions present over the 2021/22 summer.

River Turbidity

Raw water turbidity is measured at the WTP on the raw water delivery pipeline. There is a poor correlation between raw water NTU data and river flow, including when turbidity data is lagged by 1 hour for flow travel time (Figure 4). When compared with flow hydrographs the magnitude and timing of turbidity is highly variable from one flood event to the next, so flow alone is not a consistent predictor of turbidity. Some events have high turbidity and others not. During the period 1/7/2017 to 1/7/2021 the river appears to have been turbid at greater than 20NTU for less than 0.5% of the time.

Another approach is to relate turbidity to SSC and flow. The relationship between SSC and turbidity (NTU) depends on the refractive qualities of the local sediment and is determined empirically using concurrent measurements. Preliminary analysis of the suspended sediment grab sample data and the NTU data (9/1/2018 to1/12/2020) shows that while there is overlap between the two datasets, this correlation is also poor with a high level of uncertainty.

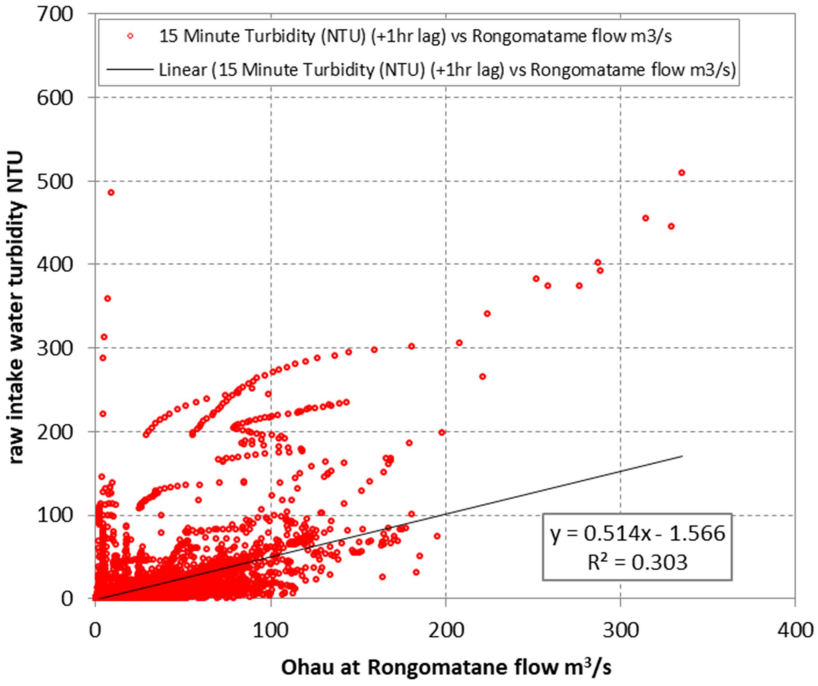


Figure 4 A correlation between flow at Rongomatane and raw water turbidity (1 Jul 2017 to 30 Jun 2021).

Another approach is to assume an arbitrary threshold when flow is likely to be unsuitable for storage due to high SSC and/or turbidity. A flow exceeding 5x median flow or some similar threshold can be used to indicate highly sediment laden flow. At this flow the gravel bed of the river is likely to be fluid and flood flows turbulent enough to entrain sediment. Excluding these flows from storage could reduce the operational cost for periodically removing sediment from the reservoir.

If a flow of 5x the median flow is assumed to represent highly sediment laden flow, then in the Ohau River the magnitude of this flow is 19.05m^3/s and is exceeded 5.2% of the time (1 Jul 1979 to 30 Jun 2021). Excluding periods with highly sediment laden flow from the remaining Core Allocation, reduces that volume suitable for storage from 1,257,000 to 1,194,000m^3, a 5% reduction in volume (Table 5). Similarly the volume in a Supplementary Allocation that would be suitable for off-river storage reduces from 22,622,000 to 10,648,000m^3, a 53% reduction in volume.

	Volume (m^3/year)	Volume excl. flow > 5x median flow (m^3/year)
Remaining Core Allocation	1,257,000	1,194,000
A Supplementary Allocation (10% flow > median flow)	22,622,000	10,648,000
Total	23,879,000	11,842,000

Table 5 Potential remaining allocation of flow in the Ohau River catchment.

The potential water volume available in the Ohau River to fill Gladstone Reservoir in an average year when both the remaining Core Allocation and a Supplementary Allocation are included is 23,879,000m^3. If highly sediment laden flow is excluded this volume reduces by 50% to 11,842,000m^3. The actual volume able to be diverted to the reservoir will depend on the volume of the reservoir, and the intake capacity and arrangement (to be confirmed).

A more objective methodology for estimating the incidence river water with a turbidity of > 20 NTU would be highly desirable. Installation one or more turbidity sensors at locations on the Ohau River would allow objective investigation of the source of turbid flow.

As a minimum, a turbidity sensor could be installed on the Ohau River at

- Rongomatane and,
- upstream of the Makahika confluence,

the difference being used to infer the contribution of the Makahika Stream and other tributaries between.

A turbidity sensor upstream of the Makahika confluence could have operational value providing early warning of turbid river flow, although turbid flow might originate at other times from other tributaries.

Under-utilisation of the existing consented river take at Levin WTP has not been calculated. This could be calculated by more detailed modelling. The under-utilised raw water could potentially be diverted to the Gladstone Reservoir during times of low supply demand, or treated water storage could be increased to improve its utilisation.

Qualitative assessment of effects on the flow regime downstream

The effect of taking flow from the Core Allocation is small. These effects have already been assessed by HRC in setting the Core Allocation in the operative One Plan.

If the full amount of the remaining core allocation were assigned to filling the reservoir (0.041 m^3/s)

- the minimum flow would not change, although the duration of the time the river flowed at minimum flow would increase marginally.
- the median flow would reduce by a marginal amount (about 1%)
- the magnitude of flushing flows would change marginally (0.4%) and any change in the frequency of these flows (FRE_3) [13] would be undetectable.

The median flow is 3.81m^3/s and the flushing flow equivalent to 3 times the median flow is 11.40m^3/s. If a Supplementary Allocation above the median flow were considered amounting to 10% of the actual river flow;

- the minimum flow in the river would be unaffected
- the magnitude of median flow in the river and the duration of time the river flowed at median flow would change marginally.
- the magnitude of flushing flows would decrease by 10% and the frequency of these flows (FRE_3) by a smaller amount.

Assuming a 0.2m^3/s intake capacity, operating at median flow and above, only 1/6 of the 10% Supplementary Allocation would be taken at 11.6m^3/s river flow. The decrease in flow would be about 2% and a change in frequency of flushing flows would likely be unmeasurable.

A more detailed assessment of effects should be undertaken when the scale of diversion that maximises the reliability of the reservoir storage in dry years is known.

Summary and Recommendations

The remaining volume in the Core Allocation for the Ohau River is 3564m^3/d which amounts to 1,257,000m^3 in an average year based on the Ohau River flow duration curve (1 Jul 1979 to 30 Jun 2021). Excluding an estimate of highly sediment laden water reduces this volume by 5% to 1,194,000m^3.

The One Plan allows the creation of a Supplementary Allocation amounting to 10% of the flow when the river flow is above the median flow. The volume in a Supplemental Allocation amounts to 22,622,000m^3 in an average year. Excluding highly sediment laden water reduces this volume by 53% to 10,648,000m^3.

In total the potential flow volume that can be allocated in the Ohau River from the core allocation and Supplementary Allocation is 23,879,000m^3 in an average year. Excluding highly sediment laden water reduces this volume by 50% to 11,842,000m^3.

Even with these reductions, the remaining Core Allocation could fill the proposed reservoir volume twice in an average year. An analysis for drier years has not been undertaken but may show that some volume from a Supplementary Allocation may be needed in these years.

[13] FRE_3 is the average annual frequency at which flow exceeds three times the median.

Two sets of concurrent flow gaugings at the Makahika confluence and Rongomatane flow gauge show that a minimum flow the flow at the Makahika confluence is about 0.23m^3/s higher than at Rongomatane and 0.27m^3/s higher at median flow. It has been assumed the flow at the Makahika confluence is the same as at Rongomatane. More concurrent flow measurements are needed to confidently define this relationship above minimum flow. The Ohau River upstream of the Makahika confluence contributes about 40% of the flow at the confluence.

Estimating the proportion of flow affected by high turbidity and/or high suspended sediment concentration is difficult due to the inconsistent relationships between turbidity (NTU), suspended sediment concentration grab samples and flow. Comparable turbidity data is needed to better understand the origin and incidence of high turbidity flows and more confidently quantify volume of highly sediment laden water not suitable for storage.

The incremental effect on the downstream flow regime from using the remaining flow in the Core Allocation for storage is not significant. The minimum flow is unaffected, and the median flow would reduce by a marginal amount (1%). Similarly, the effect on the magnitude of flushing flow events will be marginal (0.4%) and any change in their frequency (FRE_3) probably undetectable.

The effect of a fully allocated Supplementary Allocation on the downstream flow regime will not be significant. The minimum flow is unaffected. If fully allocated, the magnitude of the median flow and the duration of time the river flows at median flow would change marginally. The magnitude of flushing flows would decrease by 10% and their frequency (FRE_3) by a small amount.

More detailed assessment of available flows should include;

- collection of additional concurrent river flow and turbidity information this summer
- improved flow correlation at the Makahika confluence
- an objective correlation between turbidity and flow or rainfall
- availability of river flow volume for storage in drier years
- optimising the capacity of the intake in conjunction with intake location and reservoir volume,
- assessing impact of predicted future climate change and supply demand growth to enable reliability of storage in dry years and a resilient scheme is developed.
- updating the assessment of effects

Appendix D

JUNE 2021 HIGH TURBIDITY EVENT

JUNE 2021 HIGH TURBIDITY EVENT DETAILS

Stuff News Article

Horowhenua towns running out of water as treatment plants struggle with muddy rivers

Maxine Jacobs and Jono Galuszka · 18:03, Jun 28 2021



JONO GALUSZKA/STUFF

The Levin water treatment plant is struggling to provide clean water to Horowhenua.

Two Horowhenua towns may run out of clean drinking water, as water treatment plants struggle to process the aftermath of a deluge of rain.

Mayor Bernie Wanden urged Levin, Shannon and Tokomaru residents to conserve water on Monday as supplies dropped to critical levels.

A stay on water usage has been placed across Horowhenua after heavy rainfall put intense pressure on the district's water treatment plants.

Wanden, giving a statement via a live-streamed video, said people needed to stop using water as soon as possible.



JONO GALUSZKA/STUFF

JB's water tanker in Levin is waiting to be accessed by residents.

Water use in Levin and Shannon was exceeding what the treatment plants could provide, he said.

"There is a real risk water supplies will run out and the community will need to rely on bottled water or water tankers."

Tanks of fresh water would be available at the Shannon public toilets on Ballance St, and in Levin at the Performing Arts Centre on Queen St East, and the car park on the corner of Salisbury and Bath streets.

People should avoid doing the dishes, laundry and using baths and showers, and only flush for solid bodily waste, Wanden said.



JONO GALUSZKA/STUFF

New World Levin is almost stripped clean of water.

He urged people to contact neighbours and other residents to spread the water conservation message.

RJ's Licorice's operations manager Joe Murphy said he had been asked to shut down the factory as the township only had one hour of treated water left.

No time limit has been placed on the stay.

"For us it's huge, we're coming up to the end of our financial year, and we're doing a big project, and we're going to lose production time."

Whispers Cafe was open but only doing takeaway items.



JONO GALUSZKA/STUFF

Whispers Cafe staff (from left) Marie Moffat, Nik Patel and Mohit Patel.are manning the counter for takeaways only.

Manager Nik Patel said council staff told them the news at 9.45am, after they had made the day's cabinet food.

Going takeaway-only meant no dishes, but he was unsure what to do if the water shortage continued on Tuesday.

Manager Nik Patel said council staff told them the news at 9.45am, after they had made the day's cabinet food.

Going takeaway-only meant no dishes, but he was unsure what to do if the water shortage continued on Tuesday.

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"We will think about it tomorrow when we have got more information."

He tried to buy bottled water from supermarkets but was hampered by limited supplies.
Many food outlets along Oxford Rd in Levin have either closed or are only doing takeaways to cope with the water shortage.

Even McDonald's has closed, with cones blocking the drive-thru.

Stuff saw half a dozen drivers forlornly drive past the burger outlet within a few minutes.

Sally Weston, who turned away from a closed kebab shop, said she hoped the situation was sorted soon.

She was worried about keeping her young children clean and if the water would damage her home's hot water cylinder.

She was not aware of the council-run water tanker sites, but said she would use them over trying to buy bottled water.

The water treatment plant was pumping through 2000 litres of water per second on Sunday, and a statement from the council then suggested there were no concerns with the plant's capabilities.

Operational Data

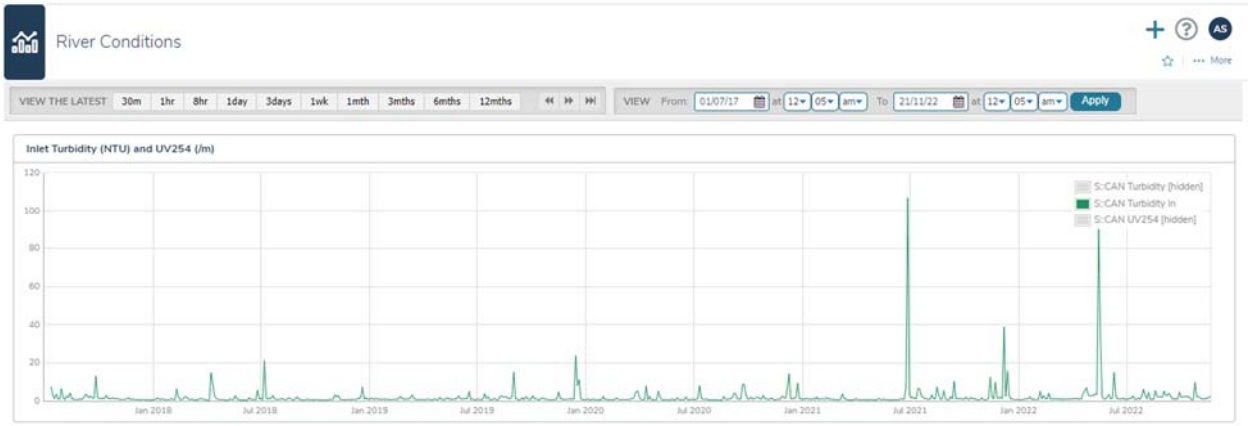


Figure 1: River conditions - inlet turbidity since 2017

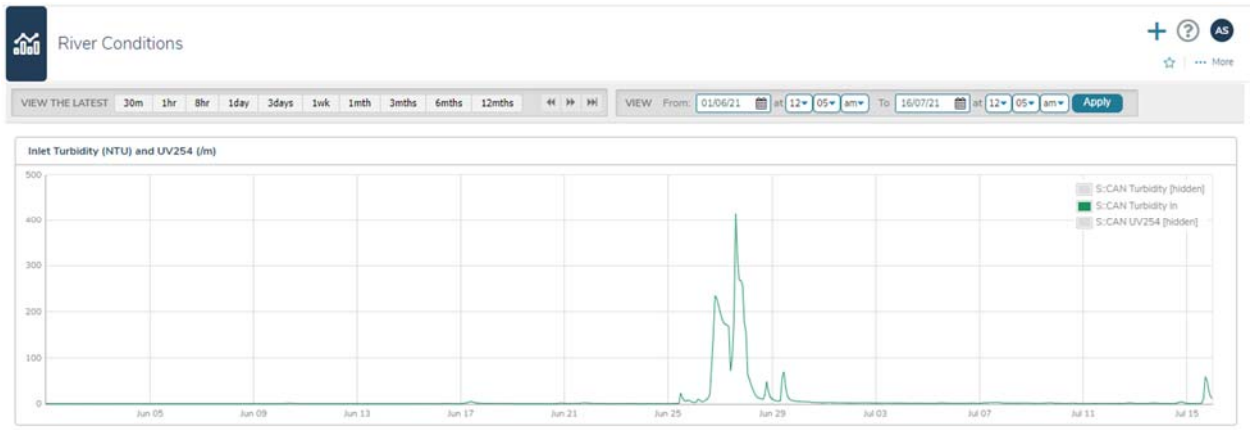


Figure 2: River conditions - inlet turbidity - June 2021 event

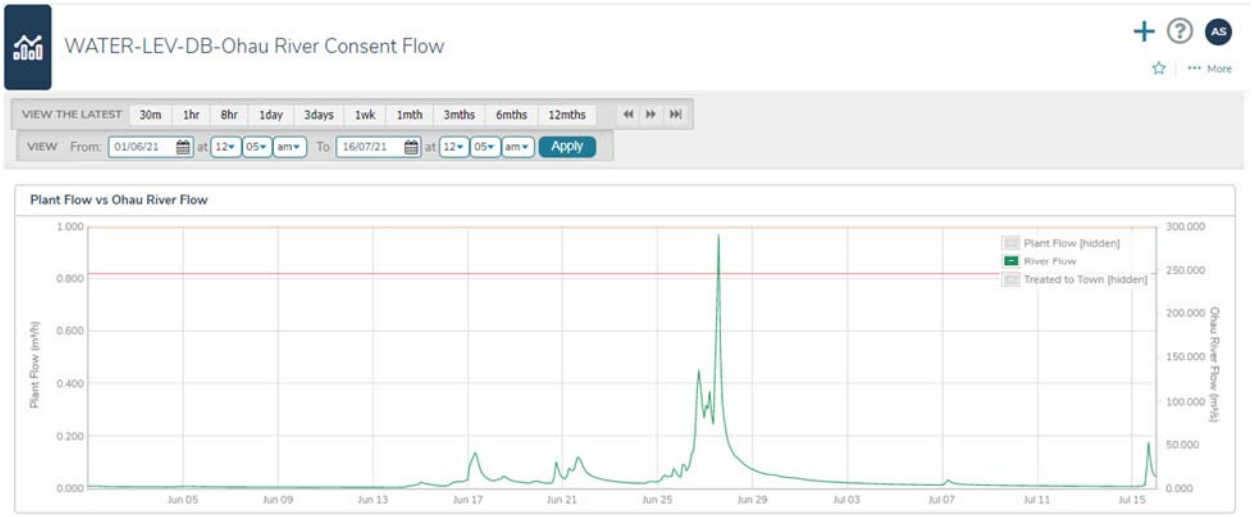


Figure 3: River Flow - June 2021 event



Figure 4: Treated Water Reservoir Levels - June 2021 event

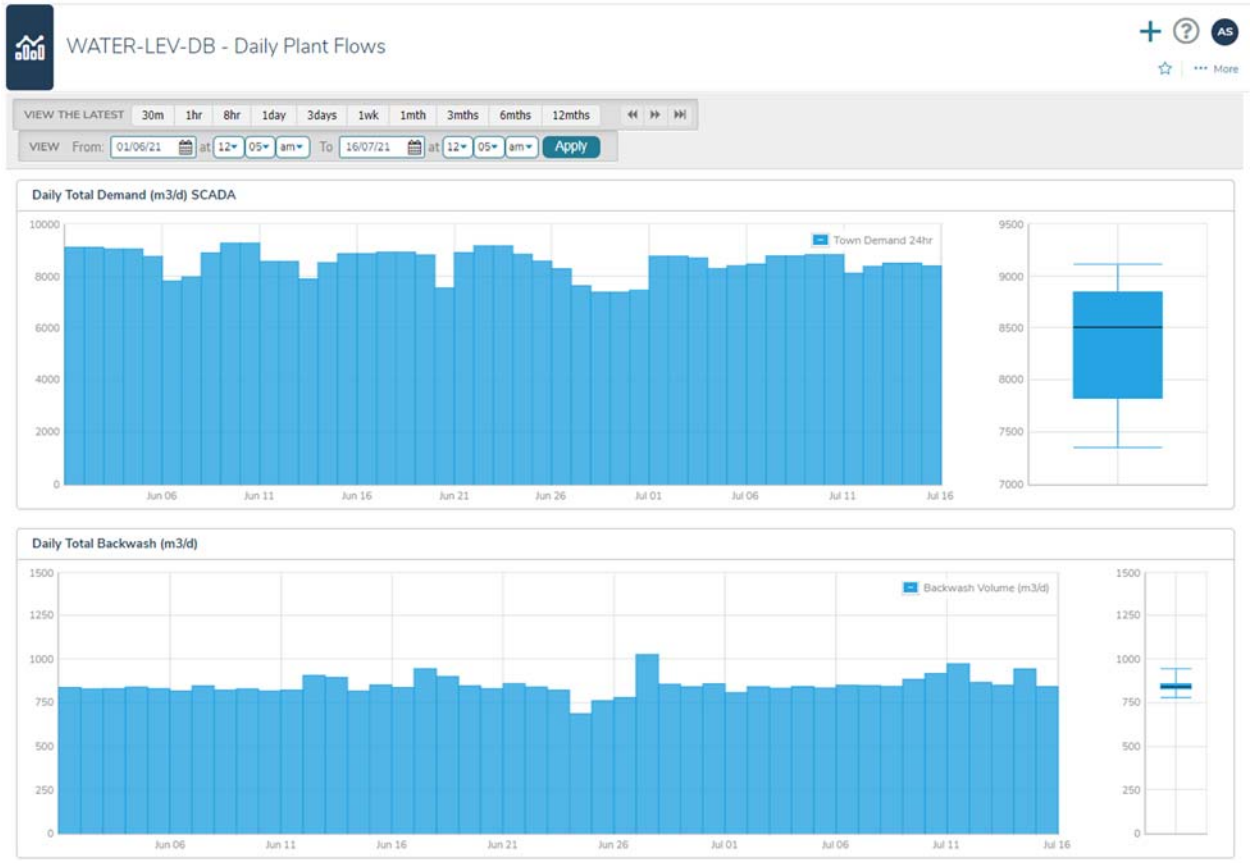


Figure 5: Demand Response to Requests to Conserve Water

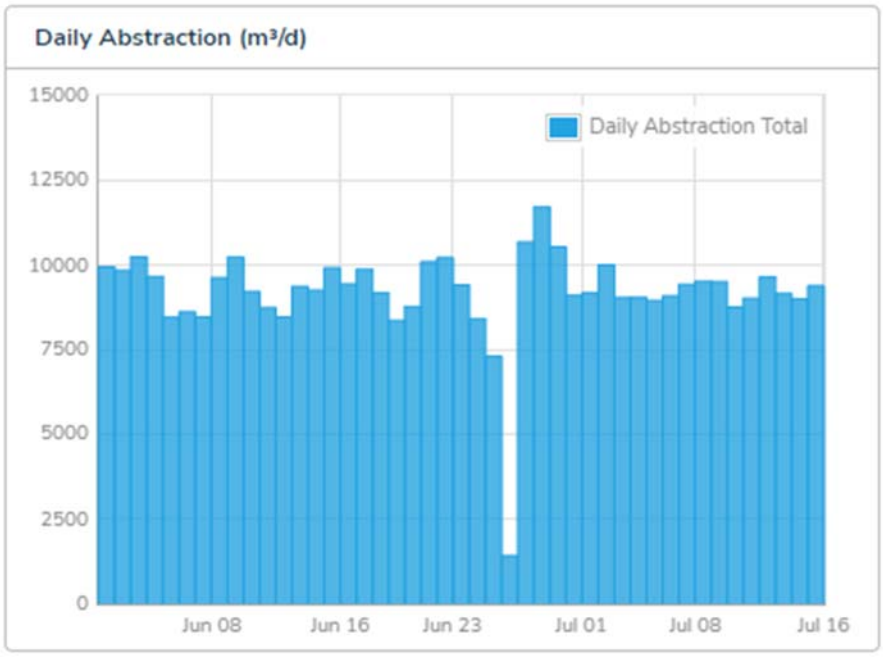


Figure 6: Daily Abstraction from River - June 2021

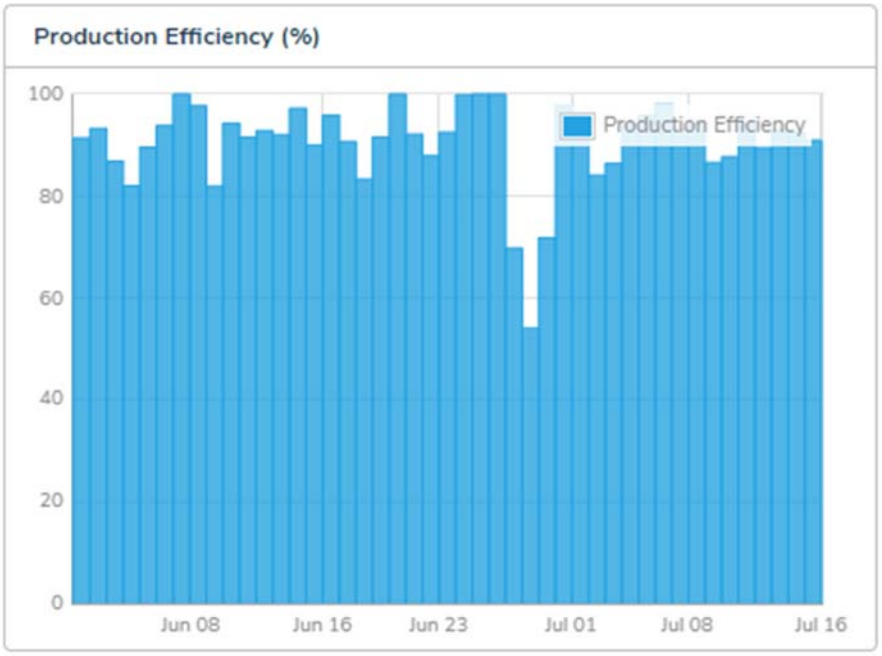


Figure 7: WTP Production Efficiency - June 2021

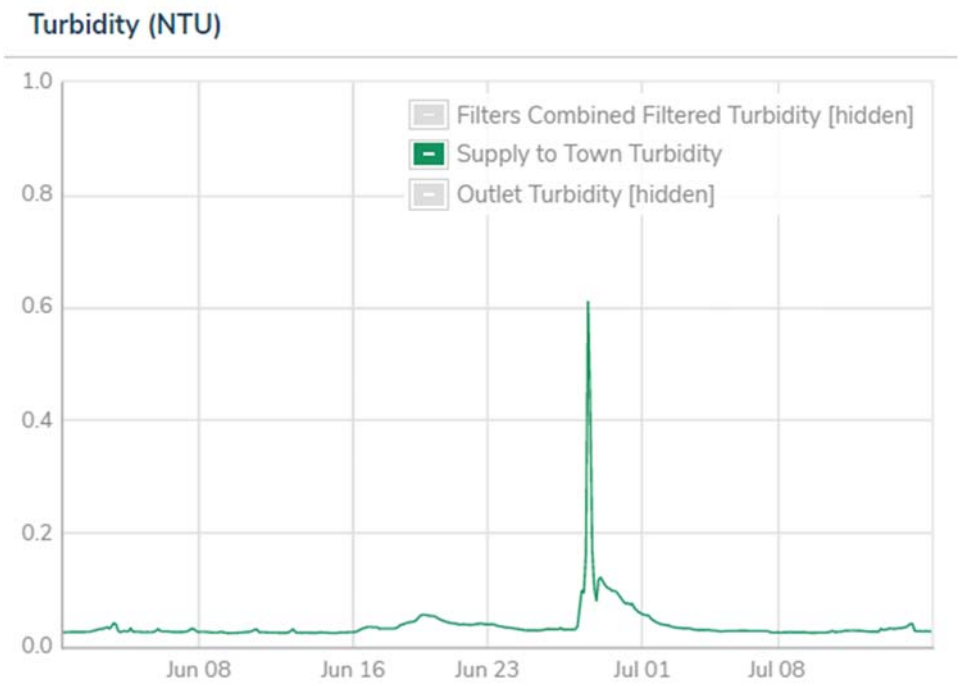


Figure 8: Treated water To Town Turbidity - June 2021

Memorandum

To:	Annette Sweeney	**At:**	Resource Management Principal, Good Earth Matters Consulting
Copy:	Craig Hiddleston		Infrastructure, HDC
From:	Dr John (Jack) McConchie	**At:**	SLR Consulting NZ Limited
Date:	19 January 2023	**Ref:**	Second pSecond peer review of Levin Water Supply Augmentation Framework.docx
Subject:	Second peer review of *Water supply augmentation operational framework, Levin Water Supply (November 2022)*		

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Introduction

At the request of Ms Annette Sweeney from Good Earth Matters Consulting, I undertook an independent peer review on behalf of Horowhenua District Council (HDC) of *Water supply augmentation operational framework, Levin Water Supply (June 2022).* I provided my peer review as a memorandum dated 8 August 2022.

Since preparing the initial report, and my peer review, considerable new information has become available. This includes recent changes to the statutory and legislative framework for the management of water resources. This material has now been included, together with some additions and amendments to address and clarify issues identified in my peer review. Consequently, the latest iteration of *Water supply augmentation operational framework, Levin Water Supply (November 2022)* has been updated considerably. As a result, I was asked by Ms Sweeney to undertake another peer review, this time of the revised report.

This memorandum provides my latest peer review but should be read in conjunction with both my earlier review and the latest iteration of the *Water supply augmentation operational framework, Levin Water Supply (November 2022).*

It should be noted that I have only reviewed the above reports and associated appendices. I was not provided with the various planning and other documents produced by, and for, HDC which underpin some of the assumptions and provide some of the base information from which this document was developed. My review assumes that the interpretation and analysis of those other documents, as presented, are correct and fairly represent the existing decision-making framework.

Overall conclusions

Following my review, I have reached the following conclusions:

- The report provides a comprehensive analysis and robust foundation from which the preferred option, *A bulk raw water storage reservoir supplied from additional water through a Supplementary Allocation from the Ohau River* has been developed.

- The areas where I believed that additional information or clarification was required have now either been addressed, to the level possible at this time, or are being addressed by further work that has been commissioned by HDC. Consequently, I believe that the concerns identified during my initial peer review have now been addressed, either quantitatively or at least qualitatively.

- The option of utilising additional water from the Ohau River, and off-river storage, allows all the risks and opportunities to be clearly identified and quantified to an acceptable level. This option is also likely to be the most cost effective and efficient solution to meeting increasing demand for potable water to support the Levin community.

- The water resource of the Ohau catchment must be viewed as a single interconnected system involving both surface water and groundwater. Since the Ohau water resource is now regarded as part of a single system, the utilisation of groundwater as a 'separate' and independent water resource is not likely to be a viable alternative. Abstraction is likely to be limited by the same constraint i.e., the current minimum flow, as applied to the Ohau River. The constraint of high turbidity is not likely to be so relevant, although this constraint has a lesser effect on option viability.

- The risks inherent in locating a deep, hydraulically isolated, source of groundwater are high and impossible to quantify with any surety. The cost of any investigation is likely to be prohibitive and success is not guaranteed. The decision to not pursue this option is therefore supported.

- While the uncertainty inherent in the various population growth scenarios is now identified, this uncertainty is impossible to quantify. I have some reservations regarding the validity of the exponential growth of demand presented, although I have the same reservations about all exponential growth scenarios. From my experience, these scenarios tend to be 'worst case' and seldom if ever occur. However, there is no doubt that the current water supply is severely constrained, and this is likely to become increasingly problematic and a significant risk to the Levin community within a relatively short period. The use of both the median and 95th percentile growth scenarios provide an envelope within which future water demand will lie. Consequently, the report allows the reader to make their own assessment of the 'reasonableness' of the argument presented and the adoption of the preferred option.

- The analysis of the risk of supply from the Ohau River was simplistic and, in my opinion, under-represented the actual risk and its potential effect, both current and future, on the reliability of this source of water. A brief discussion of the flow regime of the Ohau River, which has been monitored for over 40-years, has now been included. This allows the variability and its potential effect on water supply to be evaluated.

- While the potential effects of the minimum flow, and any resource consent condition that relates to this, can be assessed relatively easily, the effects of elevated turbidity on the water supply is more problematic. I understand that additional information is being collected on this currently that will help to define the envelope within which any Supplementary Allocation will be abstracted. However, even if prolonged

periods of elevated turbidity were a significant risk (and all indications are that they are not) these can be mitigated by changing the specification of the pumps used to abstract water and providing settling ponds etc. Consequently, I do not believe that prolonged periods of elevated turbidity represent either an 'unacceptable' or 'unmanageable' risk to the proposed water supply augmentation option proposed.

- I understand that additional work is also being undertaken looking at the reliability and variability of a potential water supply abstracted under a Supplementary Allocation. While this will help to quantify the risk to the water supply and inter-annual variability, the significant volume of water available relative to the future demand from the Levin community means that this is unlikely to affect the viability and practicality of the proposed water supply augmentation option.

- Rather than relying on simply the flow duration curves, it would be useful to include some discussion of the continuity of periods when flow is both below the minimum flow, and when turbidity is likely to be an issue. The timing of these periods with respect to the demand for water would also be useful. Some information relating to these matters has now been included and I understand that further work has been commissioned. Again, while this will provide a greater level of certainty, I do not believe that it will identify a 'fatal' or even 'significant' flaw in the water supply augmentation option proposed. Any uncertainty or extreme variations in the flow regime can, in my opinion, be accommodated by adjusting the size of the reservoir (adopting conservative assumptions) and they way in which the volume of water stored is managed.

The Levin community is going to need additional water supply in the future. While there is some uncertainty as to when this might occur, it will occur and therefore HDC need to be proactive. There is a considerable delay between planning, consenting, and commissioning a new or additional water supply. Therefore, proactive management of this issue is essential.

The use of an off-river bulk raw water storage reservoir, and water harvesting when flow in the Ohau River exceeds the median, is in my opinion the most cost-effective, practical, and realistic option. These developments will be required irrespective of any leakage, pressure, or demand management. These additional strategies are likely to only delay the need for additional water supply and not avoid the need for additional water supply at some stage in the medium term.

Despite a few areas where further explanation and justification would be beneficial, and where additional information and data are being collected and analysed, in my opinion this does not detract from the overall validity of the conclusion. Following some final editing and clarification, I believe that the *Water supply augmentation operational framework, Levin Water Supply (November 2022)* provides clear, concise, and reliable information which on the proposed water supply augmentation option can be advanced.

Final comments

These comments should be read in conjunction with the 'Tracked Change' version of the framework provided as an email attachment. In addition to the suggestions in the 'Tracked Change' version, which can be either accepted or rejected:

- The correct spelling of Ohau (Ōhau) needs to be resolved through discussion with Muaupoko. While initially I thought it was Ōhau, as it is the South Island, I was subsequently told that in this case it is Ohau (named after a person rather than a phenomenon I think).
- There are several figures and tables where the resolution was poor when I printed the document. These should be 're-inserted' in a format that allows greater resolution when printing.
- I am uncomfortable with the regression line shown on Figure 2.4 which is taken from Keane Associates (2021). I am going to discuss this with Alasdair Keane as I have also been asked to peer review his technical reports that have been prepared to support this project.
- Once my editorial suggestions and 'comments' have been considered, the formatting of the report needs to be checked to ensure that is consistent.

Disclaimer

Please note that the peer reviews were prepared for the exclusive use of Horowhenua District Council (HDC), and their agent Good Earth Matters Consulting, with respect to a specific brief. They should not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

I understood that the purpose of the peer reviews was to enhance and provide additional assurance regarding the quality of the *Water supply augmentation operational framework, Levin Water Supply (November 2022)* prepared by Good Earth Matters Consulting for HDC.

Any peer review, however, is constrained by the information provided and the responses received to various questions. In the current situation, I have undertaken only limited independent analysis as this was beyond any brief or expectation.

My peer review does not transfer any technical responsibility or legal liability from Good Earth Matters Consulting to SLR Consulting Ltd. The peer reviews do not constitute a means by which principal responsibility *Water supply augmentation operational framework, Levin Water Supply (November 2022)* can be passed on to SLR.

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Appendix B

FEASIBILITY DESIGN REPORT

DAMWATCH
ENGINEERING BEYOND THE SURFACE

Poads Road Water Storage Reservoir

17 March 2023

Prepared for Horowhenua District Council

Issue 1

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Project Title	Poads Road Water Storage Reservoir
Document Title	Feasibility Design Report
Client	Horowhenua District Council
Client Contact	Brent Maguire
Client Project Reference	Click here to enter text.
Damwatch Project No	E2142A

Document History and Status

Version No.	Issue Date	Description	Prepared by	Reviewed by	Approved by
1		Draft for Client Review	J. Eldridge D. Bardsley	S. McInerney	S. McInerney
1	17/03/23	Issue 1	J. Eldridge D. Bardsley	S. McInerney	S. McInerney

Current Document Approval

Prepared By J. Eldridge

D. Bardsley

Reviewed By S. McInerney

Approved For Issue S. McInerney Signature:

This report has been prepared by Damwatch Engineering Limited solely for the benefit of **Horowhenua District Council**. No Liability is accepted by Damwatch or any director, employee, contractor or sub-consultant of Damwatch with respect to its use by any other person.
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Executive Summary

Horowhenua District Council (HDC) intends to augment the current water supply and storage facilities to the Levin Water Treatment Plant (WTP). This augmentation is a consequence of recent population growth forecasts predicting a 2.3% to 3.0% growth at the 95th percentile, for the Horowhenua district every year between now and 2069 compared to the current level of annual growth 1.2% (Sense Partners, 2020).

The existing public water supply from the Ōhau River serves the community of Levin, taken from an intake adjacent to the existing WTP. However, it is not sufficient to meet the projected growing demand resulting from the township's growth. Under current projections the existing water take allocation will not be sufficient to meet the demand beyond the year 2034.

Damwatch has been commissioned by HDC to develop the feasibility engineering design of the water storage reservoir (referred to in this report as the Poads Road WSR).

A 740,000 cubic meter capacity water storage reservoir at Poads Road, to the east of Levin, would provide a water storage asset to support and supplement the potable water supply for Levin. The water will be extracted by a new low profile, environmentally friendly intake system buried below the bed of the Ōhau River, adjacent to the reservoir site. The pumping station at the toe of the storage reservoir will pump the water to the existing water treatment plant for treatment and prior to supplying potable water to Levin's reticulation system.

The site, on the terraces above the Ōhau River, near its confluence with the Makahika River, is constrained by the seismically active fault zone of the Northern Ōhāriu Fault to the west, the potential flood zones on the lower river terrace and land ownership boundaries. The reservoir arrangement, intake location and its arrangement, as well as the water conveyance system to the water treatment plant is the result of a multi-criteria assessment to optimise the opportunity and extend the asset's longevity. The scheme arrangement consists of:

- An infiltration galley buried into the bed of the Ōhau river, capable of extracting a variable flow up to 400 l/s along with a facility for backflushing the riverbed to maintain the efficiency of the intake.
- A single reservoir with a maximum depth of approximately 14 m when full (Full Supply Level, FSL), bounded by a broad earth embankment reservoir. Most of the materials for the embankment will be won and processed from the gravels on site. The internal face of the embankment is protected by a geosynthetic membrane. The combination of the

membrane and robust embankment arrangements provides resilience against seismic loads derived from nearby earthquake sources.

- Offtake facilities arranged to be more resilient than conventional offtakes arrangements, in recognition of the seismic loads this site may encounter.
- Twin rising mains: the material for these is flexible and durable high-density polyethylene.
- A new pipe bridge over the Ōhau River, just upstream of the existing Poads Road bridge. The bridge is to have one fixed abutment and the other can move to allow for fault movement in an earthquake on the North Ōhāriu Fault.
- Facilities to support the asset, such as an access road to Poads Road, power transmission poles, and a compressed air generator to maintain water quality in the reservoir and provide air for backflushing the intake gallery.

The report sets out the objectives, constraints, and development of the feasibility design for the reservoir and related facilities.

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Appendices

Appendix A Drawings

Appendix B Potential Impact Category Assessment

1.0 Introduction

Horowhenua District Council (HDC) intends to augment the current water supply and storage facilities to the Levin Water Treatment Plant (WTP). This augmentation is a consequence of recent population growth forecasts predicting a 2.3% to 3.0% growth at the 95th percentile, for the Horowhenua district every year between now and 2069 compared to the current level of annual growth 1.2% (Sense Partners, 2020).

The existing public water supply from the Ōhau River serves the community of Levin, taken from an intake adjacent to the existing WTP. However, it is not sufficient to meet the projected growing demand resulting from the township's growth. Under current projections the existing water take allocation will not be sufficient to meet the demand beyond the year 2034.

Damwatch Engineering Limited (Damwatch) completed a Pre-feasibility design study for a water storage reservoir, presenting three possible storage layout options (Damwatch, 2020) to provide water security for Levin.

Damwatch has been commissioned by HDC to develop one of the pre-feasibility arrangements for the water storage reservoir adjacent to the Ōhau River, approximately 6 km southeast of Levin to a feasibility design level. This report outlines the feasibility engineering design for the storage reservoir (referred to in this report as the Poads Road WSR).

In New Zealand, the recommended practice for investigation, design, construction, commissioning, operation and maintenance of large dams is outlined by New Zealand Society of Large Dams in the NZ Dam Safety Guidelines (NZDSG) (NZSOLD, 2015). Feasibility / preliminary engineering design described in this report is in accordance with these guidelines.

The NZ Dam Safety Guidelines describe a process for dam design in stages (Figure 1). The feasibility design described in this report is at a level of detail sufficient to establish technical viability, the economic implications, and to support a Resource Consent application. The Feasibility Design report covers Stage 2 and 3 of the dam design process outlined below.

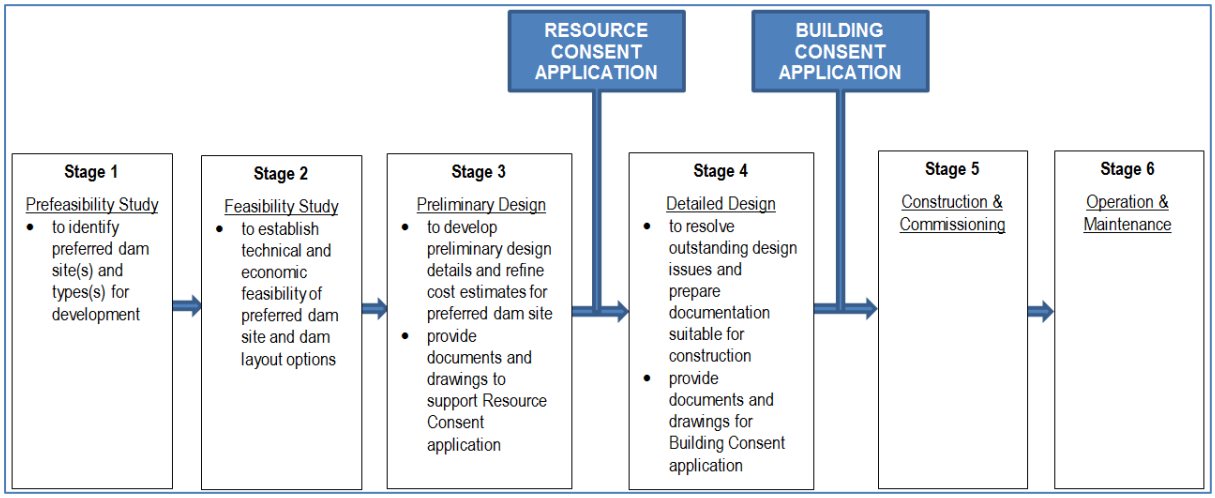


Figure 1: Typical Design Stages for New Dams (NZDSG)

2.0 Dam General Arrangement

2.1 Introduction

The pre-feasibility study assessed arrangements for a single large reservoir and two smaller reservoirs on the same site (Damwatch, 2020). The study focused on possible engineering arrangements of reservoirs on land owned by HDC on the Poads Road site. The study was undertaken prior to the assessment of community's future water demand. Consequently, the constraints imposed by the projected demand were not considered at the time of the prefeasibility study. In the intervening period, the projection of water demand has been undertaken and this influences the adoption of a scheme arrangement. The reservoir general arrangement and reasoning for adoption of a single reservoir are discussed below.



Figure 2: Pre-feasibility Single and Two Reservoir Arrangements

2.2 Water demand considerations

Table 1 below provides key data for the comparison of the two arrangements taken from the pre-feasibility design (Note: the depths and volumes of the single reservoir arrangement have been enhanced in the process of feasibility design stage presented here) and the constraints imposed by the projected water demand (Table 1):

- The volume of the first reservoir of a two-reservoir arrangement does not meet the storage requirement on first commissioning the scheme when planning staged construction.
- Therefore, both smaller reservoirs must be built at the outset to meet the storage objective.
- The two-reservoir arrangement would no longer meet the storage objective by 2035. Thus, in less than ten years after construction a new site and new scheme should be identified and subsequently built to meet the increasing demand (Typically a new reservoir requires a minimum of 3 to 5 years for investigation, design, consent and construction).
- Only the single larger reservoir will meet the storage objective at year 2042.

In summary, only the larger single reservoir meets the objectives for storage for the period to 2042.

Table 1: Assessment of water demand and storage requirements

Scheme arrangement	Reservoir	Max Water Depth (m)	Volume Capacity (m^3)	30 Day Demand Exceeds Volume (Year)[1]
Two Reservoirs	1 Upper	8 m	254,000 m^3	2022
	2 Lower	6 m	208,000 m^3	2035
Single Large Reservoir	1	11 m	702,000 m^3	2042

1 – 30 Day Demand is based on:
95% Population Growth Curve
Storage for 30 days of normal water consumption.

2.3 Water quality considerations

A consideration for the development of a reservoir system is the potential change in water quality within the reservoir through the seasons and the effect these changes might have on the downstream water treatment works.

The water quality in many water storage reservoirs in New Zealand requires active management. This management takes several different forms depending on the reservoirs' circumstances. Nonetheless, an important factor influencing water quality is the depth of water and the potential for currents mixing between the lower and higher parts of the water column.

In general, shallower water bodies tend to be more likely to be susceptible to:

- Algal growth.
- Eutrophication.

The degradation of water quality in either circumstance can be managed at a Water Treatment Plant, but at a cost in both installing appropriate equipment and ongoing expenditure on consumables. Adopting a deeper reservoir, in the single reservoir arrangement, is more likely to require less water quality mitigation measures.

Consequently, adopting the deeper single reservoir option is more likely to reduce the costs of ongoing water quality control and treatment.

2.4 Maintenance requirements

The commitments for operational maintenance have several aspects including downtime, frequency and total OPEX. The following factors favour a single large reservoir:

- **Details** - The implementation of careful details for the protection of the geomembranes within the reservoir can extend the operational life of a lining to many decades.
- **Rongomatane Intake** - Maintaining the current water intake at Rongomatane allows the reservoir to be maintained (off-line) at pre-planned times, and in unplanned outages if necessary.
- **Simplicity** – One reservoir requires approximately half the number of ancillary facilities, such as reservoir inlets, draw-off arrangements, overflow facilities and pumping arrangements.

Thus, adopting a single reservoir arrangement (which is the Option C1 from the pre-feasibility study) reduces the maintenance OPEX commitment whilst not compromising the ability to undertake maintenance within the reservoir should this be necessary.

2.5 Desilting requirements

Silt build-up in a reservoir can progressively compromise the operation of the reservoir and its capacity. This is greatly reduced for an off-line reservoir but can nonetheless be an issue if it is not addressed in the arrangement of the reservoir. The arrangement will include:

- **Raised Perimeter** - The edge of the reservoir will be raised so that in conditions less than 0.2% AEP flood there will not be any surface runoff directly into the reservoir, thereby preventing sediment runoff from the surrounding land into the reservoir.
- **Intake sedimentation** – The adoption of an infiltration gallery for the intake greatly reduces the instances of silt being pumped into the reservoir. To improve further on this performance for natural riverbed infiltration galleries, this infiltration gallery is intended to include:
    - Facilities for backflushing of the gravels around the collection pipes to improve performance and reduce sediment in the water flow.
    - A sedimentation chamber prior to the pump chamber to intercept sediment before it can be pumped to the reservoir.

Since these measures would be implemented for both reservoir arrangements, although an important consideration, this factor is not a differentiator between the two arrangements.

2.6 Capital Cost

The scheme's CAPEX comprises both the reservoir work and the ancillary facilities. Based on recent experience, the relatively small differences in earthworks and reservoir lining systems are not likely to dominate differences in total scheme cost. By contrast the fewer facilities required for a single reservoir may have a more significant impact on the scheme's cost. The facilities that are **not** required for a single reservoir include:

1. Second inlet to second reservoir.
2. Second spillway from second reservoir.
3. Overflow spillway from upper to lower reservoir.
4. Second water quality mitigation works – air bubbling systems or other.
5. Second Draw-off works.
6. Second reservoir drawdown works.
7. Second pumping station to conveyance pipeline.

The adoption of a single reservoir with a greater capacity and less ancillary works is likely to have a significantly lower cost per unit volume of water stored.

2.7 Sustainability

Building a single reservoir and associated facilities will use less resources, in total and per unit storage volume, than two reservoirs for a lower storage capacity. In addition, delaying the

construction program for the second reservoir will require the remobilisation of construction activities and increase the resource requirements further.

Consequently, the single reservoir arrangement uses resources most efficiently in both the short and long-term.

2.8 Constructability

The arrangement of both options includes the same type of elements. However, the number of additional facilities required for the single reservoir arrangement reduces:

- The complexity of coordinating many different construction activities on a confined site.
- The area required for laydown of materials.
- The number of areas required for double handling of bulk materials, i.e., processed terrace gravels for embankment earthworks.

Adopting a single reservoir reduces construction complexity, which will affect both the construction program and the CAPEX.

2.9 Site footprint constraints

The arrangements for both the single and two reservoir options maximise the use the site area for water storage.

If the two-reservoir option is split into two construction programs, separated by several years, sufficient facilities must be installed (and preserved) in the first construction program to allow the second reservoir to be constructed. The remaining area for construction activities and materials processing is limited and constrained. The requirements for the second construction program may require additional nearby but offsite areas to facilitate the construction of the second reservoir.

2.10 Resource consent considerations

There is little difference in consenting requirements or risks between the one and two reservoir options. The single reservoir option allows for consents to be obtained and given effect to in the near term. However, the consenting requirements and risks of the two-reservoir option are considered to be low.

Consenting requirements for the reservoir site itself relate to land use approvals (District Council) and earthworks consents from the Regional Council. The proposed consenting strategy would be to seek land use approvals for either the single reservoir or two-reservoir option at the commencement of the project. This is likely to be by way of Designation to provide for the site to be used for water supply purposes. If a single reservoir is adopted, all relevant details would be submitted at the time the designation is sought including any ancillary consents. If a two-reservoir option is adopted, the designation sought would provide all necessary details of the first reservoir and indicate conceptual details of the second reservoir. The designation would approve the two reservoirs with the only future requirement being to submit an Outline Plan providing details of the second reservoir prior to construction. The

purpose of the Outline Plan is so that the District Council (as consent authority) can confirm that the proposed works are in accordance with the designation.

In terms of regional council consenting, the required earthworks consents are a controlled activity under the Regional Plan. Consent applications needs to detail how erosion and sediment control will be managed. As a Controlled Activity, consent must be granted, and Regional Council is required to process these applications on a non-notified basis without requiring affected party approvals. Regional Council earthworks consents would be sought when necessary for the construction of the second reservoir, however, there is a minor cost and there is very little risk in terms of outcome and timeframes.

In summary, there is little consenting difference between the two options and, if the two-reservoir option had been adopted, the consents / approvals required to be obtained at a future date would be low risk and generally administrative in nature.

The above is based on an assessment of the current regulatory framework. RMA reform is proposed, and the details of the reform are not yet known. The reform is proposing a Strategic Planning Act which will require Long-term Spatial Strategies to be developed identifying infrastructure requirements. Subject to the reservoir being recognised in the Long-Term Spatial Strategy, the proposed reform should not constrain construction of a second reservoir at a later date.

2.11 Building consent considerations

There are advantages to implementing all the works in a single program of work, for the following reasons:

1. A single reservoir requires only one design document and one building consent.
2. Two reservoirs with additional facilities, built in one program requires a more complex design and a more complex regulatory review for the consent process.
3. If the construction program of a second reservoir is delayed by more than a few years, a second design document is required to demonstrate compliance at the time of the application and a new building consent.

In summary, there are advantages to adopting a single reservoir in reducing complexity and reducing the expense of obtaining a Building Consent.

2.12 Summary of considerations

Table 2 summaries the advantages and disadvantages of a single reservoir option over a two-reservoir option. The final column to the right of the table provides a summary of the overall advantage or disadvantage of a single reservoir arrangement.

Table 2: Summary assessment of general arrangements

Criterion	Advantages of Single Reservoir	Disadvantages of Single Reservoir	Overall Merit of One Reservoir
1 Water Demand	Only arrangement meeting demand requirement	None	Advantage
2 Water Quality	Deeper water is better for water quality management	None	Advantage
3 Maintenance Requirements	Significantly reduced maintenance responsibilities	If reservoir maintenance is necessary, the full storage offline must be taken offline.	Advantage
4 Desilting Requirements	Silt exclusion is the same for both arrangements	If necessary, must take the full storage offline	Neutral
5 CAPEX reduction	Significant reduction of additional facilities	Only minor CAPEX staging can be achieved.	Advantage
6 Sustainability	Constructing one reservoir with fewer resources at one time is more sustainable than the alternatives,	None	Advantage
7 Constructability	Significantly simpler to program and build.	None	Advantage
8 Site Footprint Constraints	The site area is sufficient to allow a single construction program.	None	Advantage
9 RMA Resource Consents	The requirements are roughly the same for both options	None	Neutral
10 Building Consents	Only a single design and building consent is economic in effort and cost.	The works must be constructed as set out in the consent.	Advantage

2.13 Performance Requirements

As a result of the various considerations outlined above the single reservoir arrangement is progressed in this feasibility study. The reservoir and its attendant facilities have performance requirements to meet the objectives to support the water storage for Levin's Water Treatment Plant. These requirements are both general and specific (Table 3 and Table 4).

Table 3: General performance requirements

	General Requirement	Value
1	Seismic performance of the scheme to the WTP	**SLS / OBE 1 : 500 AEP**
2	Buffer zone between Fault and Reservoir	**250m**
3	Quarrying commercial considerations	None
4	Water demand curve	95 % Population Growth Curve
5	Seasonal water demand variation	No consideration
6	Min Storage requirement	30 days normal demand in 2042
7	Water Demand in 50 years	40,000 m^3/day
8	Consent application – Intake B1	7,500 m^3/day
9	Consent application – Intake B1	10% above median flow
10	Flow measurement / recording accuracy	Equivalent m^3/hr (round up)
11	Climate change river hydrology	No discernable change - daily flows
12	Climate change considerations for works design	Spillway capacity only
13	Water quality at intake	Provide flexibility
14	Flood protection level from river	All works above 1 : 1,000 AEP Nominal 118 m RL

Table 4: Specific performance requirements

	Requirement	Value
1	**River intake**	**Ōhau Intake**
2	Minimum flow drawn from river (Ōhau River)	7,500 m^3/day
3	Maximum flow drawn from river (Ōhau River)	~400 l/s and 34,560 m^3/day
4	Flood level protection (flood in river e.g. 1 : 100, 1 : 2,500)	1 : 1,000 AEP Nominal 118 m RL
5	Infiltration gallery	High Yield - Backflush
6	Water Sampling - Drinking Water Standards NZ Nov 2022 Taumata Arowai – Monitoring, QA, Aesthetics	Monitoring & Assurance
7	**Reservoir**	**Single Reservoir**
8	Volume storage	740,000 m^3
9	Boat ramp	Yes
10	**Dam**	**Earth Embankment**
11	Potential Impact Category	Medium
12	Separation of groundwater	Yes
13	**Draw-off from reservoir**	**On side slope**
14	Maximum draw off (18,564 m^3/day) (year 2042)	108 l/s x 2 each level
15	Number of levels for draw off	2 levels
16	Isolation upstream end	Yes
17	Pumping station	Dry well
18	Water quality sampling - Drinking Water Standards NZ Nov 2022 Taumata Arowai – Monitoring, QA, Aesthetics	Monitoring & Assurance
19	**Drawdown facility**	**To Spillway**
20	Pipes	2 number

21	Energy dissipation	Vertical Stilling Wells
22	**Rising Main to WTP**	**To WTP**
23	Number of pipes	1 + 1 – in trench
24	Flow (To meet 2042 demand)	2 x 108 l/s
25	Flow velocity	Max 6 m/s
26	Distance to WTP	~3.26 km
27	**Pipe bridge**	**Stand alone**
28	Seismic serviceability criterion	SLS 1 : 500 AEP
29	Lateral displacement (strike slip) across fault	3 – 4m (Mw 7.2)

Table 5: General arrangements

	Parameter (NZVD2016 vertical datum)	Value
1	**River intake**	**Ōhau Intake**
2	Riverbed level (nominal)	112 m RL
3	Riverbank level (nominal as formed by works)	118 m RL
4	**Reservoir**	**Single Reservoir**
5	Embankment Crest Level	132 m RL
6	Full Supply Level	130.9 m RL
7	Lowest level in pond base	120 m RL
8	Ground elevation at outside embankment toe	118 m RL
9	**Reservoir area and volume**	
10	Reservoir area at embankment crest	87,500 m^2
11	Reservoir area at Full Supply Level	85,000 m^2
12	Reservoir area at pond base	50,200 m^2
13	Reservoir volume at Full Supply Level	740,000 m^3
14	Reservoir volume at embankment crest level	855,000 m^3
15	**Embankment**	
16	Embankment height	14.0 m
17	Crest width	6 m
18	**Conveyance pipe**	**To WTP**
19	Rising mains number	2
20	Rising main diameter	267 mm ID

3.0 PIC and Dam Break

3.1 Introduction

The performance requirements and design criteria for a new dam are established based on the significance of the dam and its reservoir to the area and community downstream. The considerations and factors for deriving these criteria and requirement are set out in the NZDSG (NZSOLD, 2015), which include a classification system categorising large dams as being a "Low", "Medium" or "High" Potential Impact Classification (PIC). The PIC reflects the potential impact a hypothetical dam failure might have on downstream people, property, infrastructure, and the environment. In the design process, a dam's PIC provides the performance criteria to be achieved by the design:

- High PIC dams, for which failure would have a major impact on downstream people, property, and the environment, should be designed to meet high performance criteria.
- Medium and Low PIC dams, of which failure would have a lesser downstream impact, have progressively lower performance criteria.

The PIC of a dam has no correlation with the probability of the dam failing or experiencing a dam safety incident. The PIC does however define the design criteria and performance requirements of the dam and its related facilities.

3.2 PIC Assessment Methodology

The methodology and criteria for assessing a dam's PIC are currently under review as part of the forthcoming dam safety regulations. As part of the detailed design changes to the approach and criteria will be incorporated into the design process. However, for this feasibility design the current methods and well understood criteria are adopted in the assessment.

The methodology for evaluating a dam's PIC is summarised as follows:

- **Dam-break flood hazard assessment:** Evaluate the possible rate of release of the reservoir storage for hypothetical dam failure scenario(s) and estimate the resulting downstream flood hazard due to propagation of the dam-break flood wave.
- **Consequence assessment:** Using the results from the dam-break flood hazard assessment, assess the impact of a hypothetical dam failure on downstream people, property, infrastructure, and the environment.
- **Assign Potential Impact Classification:** Using the results from the consequence assessment, assign a PIC to the dam using the classification tables provided in the NZDSG.

The assessment considers the consequences of a hypothetical dam-break flood on:

I. Life safety.
II. Residential houses.
III. Critical or major infrastructure.
IV. Natural environment.
V. Community recovery time.

Criteria from the NZDSG are used to evaluate the PIC. The method requires the assessment of the "damage level" to items II to IV above, as either minimal, moderate, major, or catastrophic.

After the damage level is established, this is used to determine the PIC, by aligning the highest assessed damage level with the life safety impact (item I above) which is measured primarily by the downstream Population at Risk (PAR). In some situations, further considerations are necessary to assess whether "it is highly likely that a life will be lost" or whether it is "highly likely that two or more lives will be lost".

3.3 Level of Dam-break Flood Hazard and Consequence Assessment

To inform the develop of a PIC assessment the NZDSG permits varying levels of details for a hypothetical dam-break flood hazard and consequence assessments. The New Zealand Dam Safety Guidelines discuss three different levels of assessment which are summarised as follows:

- **An initial assessment** is based on readily available data and existing knowledge or from a qualitative estimation of the magnitude of a potential dam-break flood. It is likely to be conservative and may raise uncertainties that need to be resolved by an intermediate or comprehensive level of assessment.
- **An intermediate assessment** requires a more quantitative assessment in terms of the dam-break flood hazard and resulting downstream impact to people, property, and the environment.
- **A comprehensive assessment** is typically required for dams that would have considerable downstream impact in a hypothetical dam failure event, or if there are unresolved uncertainties from an initial or intermediate assessment. This level of assessment requires detailed computational hydraulic modelling of the dam-break flood and detailed data gathering to determine the downstream impact to people, property and environment.

The level of PIC assessment for the Poads Road reservoir is at an "intermediate" level which is appropriate for the location, project stage, and based on existing data and limited hydraulic calculations.

3.4 Embankment Dam Breach

The NZDSG normally requires consideration of hypothetical 'sunny day' and 'rainy day' dam failures, the latter occurring in a flood situation. However, the proposed Poads Road WSR is an off-river storage facility, comprising only its own catchment area, it will be unaffected by floods so only a sunny day type dam failure is relevant.

It is assumed that a hypothetical breach in the perimeter embankment occurs when the water level reaches the embankment crest level. This assumption provides the worst possible indication of the downstream impact from a hypothetical dam-break flood. Thus, the full volume of stored water could be released downstream if the embankment breached at the highest embankment profile, which is on the northern side of the reservoir.

These assumed conditions reflect a potential failure mode where the reservoir is overfilled by pumping (to the embankment crest level) due to blockage of the spillway and draw-off system

and failure of the control system to switch off the pumped inflows. Given the width of the spillway crest this represents a very unlikely occurrence. Nonetheless in the scenario the embankment crest then overtops, resulting in erosion of a breach in the embankment and release of the stored contents of the reservoir downstream.

The breach might occur at any point on the embankment perimeter where it is raised above natural ground level. It has been assumed that breach occurs at the highest embankment on the northern side of the reservoir. This will provide a “worst case” scenario on which to base the PIC.

An alternative breach scenario could be damage to the liner leading to internal erosion either through the embankment or along a conduit penetrating through the embankment, ultimately leading to a breach of the embankment and an uncontrolled release of the reservoir water. However, this breach would occur during normal operating conditions with a lower reservoir level than the assumed breach scenario mentioned above, and result is a less conservative peak breach outflow and volume.

3.5 Breach Flood

The peak breach outflow and breach development time for failure (Froehlich, 1995) at the maximum embankment height have been estimated with the methods provided by Froehlich (2016). The results are summarised below.

- Reservoir depth at time of failure = 12 m
- Reservoir volume at time of failure = approximately 855,000 m^3
- Peak breach outflow: = approximately 660 m^3/s
- Breach development time = approximately 20 to 30 minutes.
- Time to empty reservoir = approximately 40 to 50 minutes.

If the breach occurred where the embankment has a lower height, the peak dam breach outflow and volume released would be less than the values indicated above.

A simple, triangular shaped breach outflow hydrograph (Figure 3) was developed based on the parameters listed above and using the methodology outlined in (Bowles, et al., 2000).

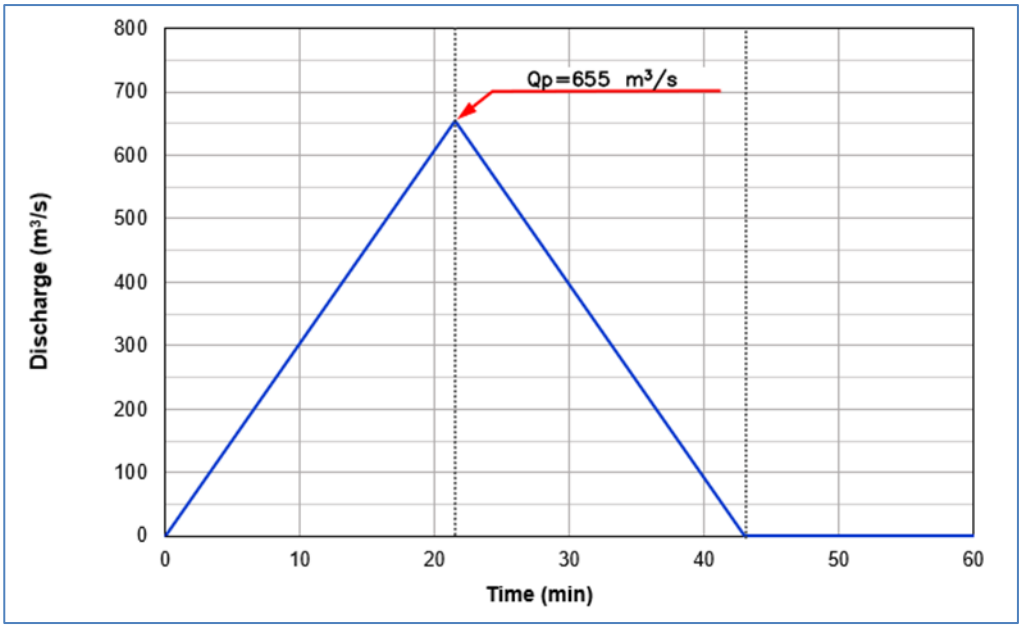


Figure 3: Simplified Triangular Breach Outflow Hydrograph

3.6 Dam-Break Flood Inundation Areas

A MIKE21 two-dimensional computational hydraulic model covers the area downstream of the reservoir, following the Ōhau River to the coast. The model estimates the maximum dam-break flood inundation extents and depths. Ground elevations in the model adopt those from a LiDAR aerial survey data supplied by Horizons Regional Council for areas downstream of the Levin Water Treatment Plant (WTP).

The MIKE21 model simulates the hypothetical dam-break flood scenario described above, based on the breach outflow hydrograph. A flood map (Appendix B) of the maximum flood inundation area for the hypothetical dam-break flood scenario indicates areas where flood depths are less than 0.5 m in light blue shading and greater than 0.5 m in dark blue shading.

The dam-break flood inundation map indicates that the dam-break flood extent is confined by the river terraces which bound the Ōhau River between the reservoir site and the WTP. Downstream of the Levin WTP the flow breaks out on Ōhau River floodplain areas, including locations:

- Around Florida Road, just south of the Levin WTP.
- The Kimberley Reserve.
- Low-lying farmland areas to the west of the SH1 road bridge.

There are stopbanks along parts of the Ōhau River downstream of the SH1 bridge. However, the stopbank crest levels have not been specifically included in the MIKE21 model. Predicted flood depths and extents may differ from those shown estimated if:

- The stopbanks are included in future refinements of the MIKE21 model.
- A more “comprehensive” dam-break flood hazard assessment is undertaken.

The dam-break hydrographs at locations along the Ōhau River to the coast indicate the peak breach discharge of about 560 m^3/s at the dam breach location, and this peak attenuates with distance as it is flows along the Ōhau River and into the floodplains (Figure 4).

Key observations are:

- The peak breach discharge at the reservoir is 655 m^3/s.
- At State Highway 1 (SH1) bridge the peak discharge has reduced to about 212 m^3/s.
- At Soldiers Road the peak discharge is approximately 97 m^3/s.
- At the river mouth this has reduced further to about 14 m^3/s.
- At the Rongomatane gauging station, about 500 m downstream of the reservoir the peak breach flow is roughly equivalent to a 1 : 100 AEP Ōhau River flood (Table 6Table 6: Flood peak discharge (m3/s) for the Ōhau River at Rongomatane flow gauging site).
- At the SH1 bridge, the peak breach flow is estimated to be less than the mean annual flood discharge of about 234 m^3/s.

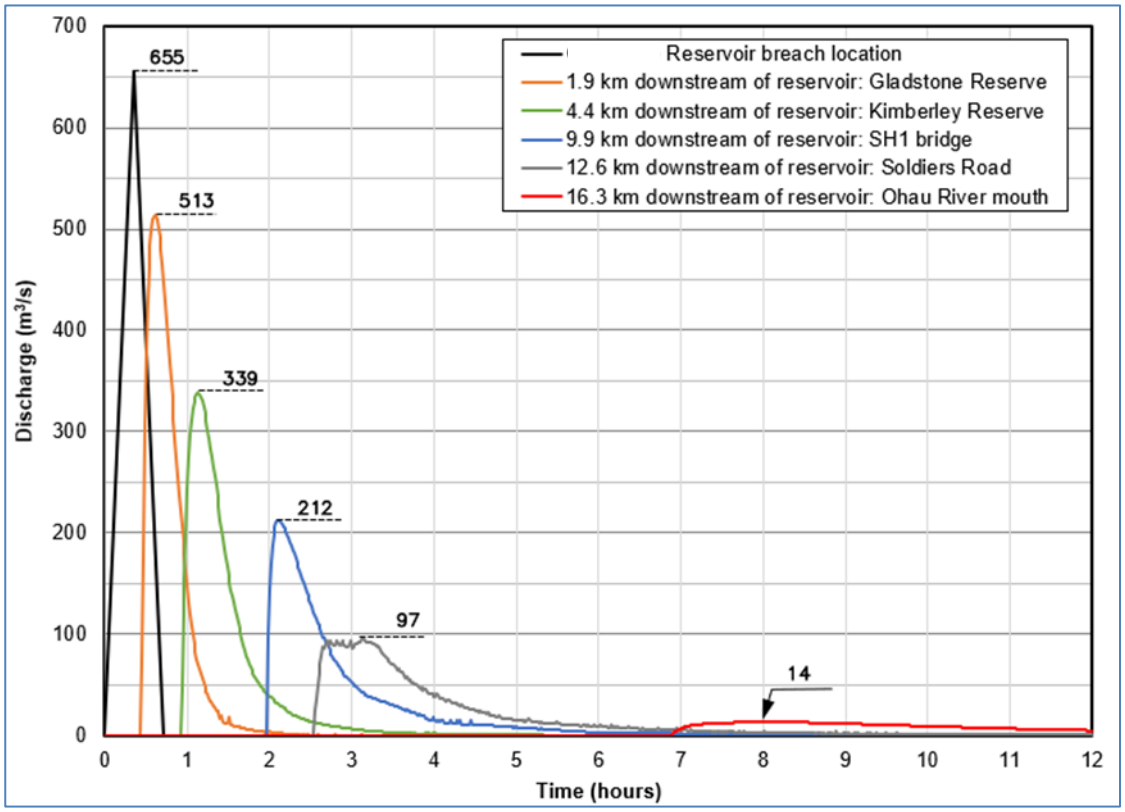


Figure 4: Dam-break Flood Hydrographs at Locations Downstream

Table 6: Flood peak discharge (m^3/s) for the Ōhau River at Rongomatane flow gauging site

Source	Annual Exceedance Probability (1 in Years)					
	2.33	5	10	50	100	1000
NIWA (2020)	234	308	367	499	554	738
Philpott (2020)	NA	NA	NA	507	584	NA

3.7 Consequence Assessment

The dam-break flood inundation model combined with overlays of topographic maps and aerial photographs provide an indication of areas potentially impacted by a hypothetical dam breach of the dam. The Population at Risk is assessed using the approach developed specifically for New Zealand conditions (Veale, Webby, & Henden, 2019).

Appendix B lists potentially affected locations of interest in the dam-break flood inundation area. The locations referred to by an “ID Number” in this list are also shown on the flood map (Appendix B).

No site inspection was carried out to verify the usage type of potentially affected buildings. Consequently, there is some uncertainty on the usage type (e.g., residential dwelling, commercial building, farm building) of buildings identified from aerial photographs. Where there is uncertainty, buildings are assumed to be residential dwellings, a classification yielding the most onerous outcome.

The following summary describes the potential consequences in terms of the damage level categories listed in the NZDSG.

- **Community:**
  There are four residential dwellings in the potential dam-break flood inundation area. Three of these dwellings are inundated to a maximum depth in the range of 0.1 to 0.2 m, and one to a maximum depth of 0.5 m. These building would be unlikely to suffer structural damage but, if the building floor level is close to the ground, dam-break floodwaters could enter these buildings and affect building interiors or contents.

  No community facilities, commercial or industrial facilities are identified in the dam-break flood inundation zone. The Water Treatment Plant intake is described under the “critical or major infrastructure” item below.
  The damage level to residential houses is assessed to be “Minor” based on Table 7 and a “minimal” damage level is selected for residential houses.

- **Cultural:**
  A search of the New Zealand Heritage List/Rārangi Kōrero the Department of Conservation national register of heritage sites which they manage and the Horowhenua District Council webmaps indicates there are no historical or cultural sites forming “part of the historical and cultural heritage of New Zealand” within the potential dam-break flood inundation area.

There is no expected loss to any historical or cultural sites and based on Table 7 "Minimal" damage level is selected for the cultural category.

- **Critical or Major Infrastructure:**
  Critical or major infrastructure includes lifelines (e.g., power supply, water supply, transportation systems, etc.) emergency facilities (e.g., hospitals, fire stations, etc.) and large industrial and commercial facilities. Critical and major lifelines are network mains and nodes (e.g., state highways or major electric power transmission line) rather than local connections.
  The critical or major infrastructure identified in the dam-break flood inundation area include those listed below.
  1. Levin WTP intake.
  2. SH2 road bridge.
  3. North Island Main Trunk railway bridge.
  4. Transpower 220KV overhead powerline and pylons.

  However, the peak dam-break discharge at these structures are all less than a moderate flood on the Ōhau River for which these structures would have been designed and as such are not expected to sustain any significant or lasting damage.

  A damage level of "minimal" is selected for "critical and major infrastructure" from a "time to restore operation" of up to one week (Table 7**Error! Reference source not found.**).

- **Natural Environment:**
  The dam breach outflow is expected to largely be confined to the extent shown on the dam-break flood inundation map (Appendix B). The land within this inundation zone largely consists of open, floodplain areas near the Ōhau River used for agricultural purposes. Local erosion and deposition of silt on the floodplain areas and Ōhau River is expected.

  Fish and invertebrate species in the river could be threatened by the sudden increase in river flow due to the dam-break flood and by deposition of eroded embankment material on the riverbed.

  Based on Table 7, the damage level to the natural environment is assessed to be "moderate" representing "significant but recoverable damage".

The highest damage level from the above categories is "moderate" and this has been selected to assess the PIC.

Table 7: Determination of Assessed Damage Level (reproduced from the Building (Dam Safety) Regulations 2022)

Damage Level	Specified categories				
	Community	Cultural	Critical or major infrastructure		Natural environment
			Damage	Time to restore to operation [1]	
Catastrophic	One or more of the following apply: • 50 or more household units rendered uninhabitable. • 20 or more commercial or industrial facilities rendered inoperable. • 2 or more community facilities rendered inoperable or uninhabitable.	Irreparable loss to 2 or more historical or cultural sites.	Two or more critical or major infrastructure facilities rendered inoperable.	One year or more.	Extensive and widespread damage, with permanent, irreparable effects on the natural environment.
Major	One or more of the following apply: • 4 or more but less than 50 household units rendered uninhabitable. • 5 or more but less than 20 commercial or industrial facilities rendered inoperable. • 1 community facility rendered inoperable or uninhabitable.	One or both of the following apply: • irreparable loss to 1 historical or cultural site. • loss to 1 or more historical or cultural sites where it is possible, but impracticable, to fully restore the site.	One critical or major infrastructure facility is rendered inoperable.	Three months or more but less than 1 year.	Extensive and widespread damage where it is possible, but impracticable, to fully restore or repair the damage.
Moderate	One or more of the following apply: • 1 or more but less than 4 household units rendered uninhabitable. • 1 or more but less than 5 commercial or industrial facilities rendered inoperable. • loss of some functionality of one or more community facilities.	Significant loss to 1 or more historical or cultural sites where it is practicable to restore the site.	One or more critical or major infrastructure facilities are affected by the loss of some functionality.	Less than 3 months.	Significant damage that is practicable to restore or repair.
Minimal	Minor damage that does not materially affect the functionality of any household unit, commercial or industrial facility, or community facility (or no damage).	Loss to 1 or more historical or cultural sites that will require minor restoration only (or no loss to any historical or cultural site).	Minor damage to 1 or more critical or major infrastructure facilities (or no damage).	One week or less.	Only minor rehabilitation or restoration may be required, or recovery is possible without intervention (or no damage).

Notes associated to Error! Reference source not found.

1. The estimated time required to repair the damage sufficiently to return the critical or major infrastructure to the normal operation that the infrastructure had immediately before the failure of the dam

Supporting Information to Table A1(from Section 3 of the Building (Dam Safety) Regulations 2022)

For the "Community" specified category:

- A commercial or industrial facility:

(a) means a building, other than a farm building, that is used for commercial, business, industrial, or professional purposes, but:
(b) does not include any critical or major infrastructure.

- A community facility means any of the following:

(a) an early childhood education and care centre or registered school within the meaning of section 10 of the Education and Training Act 2020.
(b) the premises of an institution within the meaning of section 10 of the Education and Training Act 2020.
(c) a rest home or a residential disability care institution (within the meaning of section 58(4) of the Health and Disability Services (Safety) Act 2001).
(d) a building that is used to provide health or disability services as defined in section 5 of the Health and Disability Services (Safety) Act 2001 (other than a hospital building referred to in paragraph (b) of the definition of critical or major infrastructure).
(e) a marae, a community hall, or an event centre.

For the "Cultural" specified category:

- Historical or cultural sites:

(a) means any of the following that forms a part of the historical and cultural heritage of New Zealand:
(i) land, including an archaeological site, a cemetery, or urupā (or part of an archaeological site, cemetery, or urupā).
(ii) a building or structure (or part of a building or structure).
(iii) any combination of land, buildings, structures, or associated buildings or structures (or parts of buildings, structures, or associated buildings or structures), and;
(b) includes anything that is in or fixed to land described in paragraph (a)

For the "Critical or major infrastructure" specified category.

- Critical or major infrastructure means any of the following:

(a) building or other infrastructure operated or used by a lifeline utility within the meaning of section 4 of the Civil Defense Emergency Management Act 2002 (e.g., electricity, water, sewage, gas, telecommunications, and rail infrastructure).
(b) a hospital building that is likely to be needed in an emergency (within the meaning of section 4 of the Civil Defense Emergency Management Act 2002) to provide:
(i) emergency medical services, or;
(ii) ancillary services that are essential for the provision of emergency medical services.
(c) a building that is used to provide emergency response services (for example, policing, fire, ambulance, or rescue services).
(d) buildings or infrastructure that are essential to the containment of a hazardous substance (as defined by section 2 of the Hazardous Substances and New Organisms Act 1996):
(d) the dam, another dam, or flood protection works if the service that the dam, other dam, or flood protection works provide is critical to the community and that service cannot be reasonably provided by alternative means

3.8 PAR Assessment

The population exposed to a potential dam-break flood inundation area is termed the "Population at Risk" (PAR) in the Building (Dam Safety) Regulations. The PAR is defined as:

> "the number of people likely to be affected by an uncontrolled release of all or part of the stored water or other fluid due to a failure of the dam (assuming that no person takes any action to evacuate)."

The PAR includes both permanent populations (e.g., people in houses or workplaces) and temporary populations (e.g., road users, anglers, farm workers, etc.). Note that estimates of the PAR do not equate to potential loss-of-life estimates.

For the purposes of this assessment, people are considered "likely to be affected" and included in the PAR count where the maximum depth of flooding is greater than 0.5 m deep. This threshold is based on guidance from the NZDSG.

The assumed hypothetical failure of the reservoir at Poads Road occurs under sunny day conditions (dry weather) when the downstream PAR would be unaware and not expecting advancing and rising floodwaters. Anyone within the PAR would have limited warning of the flood's arrival unless they were alerted by other means.

Locations where PAR could be located are identified with an ID number on the dam-break flood inundation maps in (Appendix B). The key locations where people could be present and affected by dam-break flood waters greater than 0.5 m in depth, are:

- the residential dwelling near Riveredge Terrace.
- the Ōhau River gravel extraction site near Poads Road.
- the Gladstone and Kimberley Reserves.

Note that the estimated maximum flood depths around the four impacted residential dwellings (refer to the 'Community" damage category described above) are all less than 0.5 m so that these residential dwellings do not contribute to the PAR.

One person operating machinery at the Ōhau River gravel extraction is conservatively assumed for the PAR assessment. Inspection of aerial photographs also indicates there is a gravel extraction area in the lower portion of the Ōhau River. However, this area appears to be less frequently used and no population has been assigned for PAR assessment purposes.

There are five reserves managed by Horowhenua District Council (HDC) near the Ōhau River. These reserves are the Gladstone Reserve, Kimberley Reserve, Kirkcalides Reserve, a river access way off Muhunoa East Road and Parikawau Reserve and referred to as the "Ōhau River Reserves". Of these five, the Gladstone Road, Kimberley and Parikawau Reserves are the most popular (HDC, 2017). The following lists the occupancy assumptions for these reserves adopted for PAR assessment:

1. The Gladstone Reserve is used as a picnic and swimming access area in the summer and has toilet facilities (HDC, 2017). A PAR estimate of two people during the summer months has been conservatively assumed.
2. The Kimberley Reserve is the largest of the reserves and is a popular spot for camping (by permit from HDC during the summer months) and is also used as a picnic, dog-walking, and swimming area (HDC, 2017). Toilet facilities are available. Inspection of satellite photos indicates between two to 20 vehicles are parked in the reserve area during daylight hours in the summer months. Assuming two people per vehicle, an estimate of between four to forty people could be present in the reserve area during the peak of the summer. For PAR assessment purposes, a representative population of 10 people has been adopted for this reserve.
3. The other reserves are relatively small and are understood to not be frequently visited. However, the Parikawau Reserve is known to be used as a layover area for people travelling on SH1 (HDC, 2017). For PAR assessment, no people have been included in these reserves.

The temporary populations at the locations described above will depend on the time of day (i.e. day-time or night-time) and season (e.g. summer or winter) when a potential dam failure event occurs. The assumed population numbers described above represent a situation where a potential dam failure event occurs during the daytime over the summer period.

Appendix B lists the estimated PAR for people in vehicles and on roads affected by the potential dam-break flooding. This indicates that one person in a vehicle on Gladstone Road may be impacted and this person has been included in the total PAR estimate. The calculations include an assessment of the exposure time to people in vehicles on the roads into account using the methodology outlined in Environment Agency (2013).

Finally, people may also be present on agricultural land affected by the dam-break induced flooding. This would be particularly around the Florida Road area, to the south of the WTP. One person has conservatively been assumed in the total PAR to account for this potential population.

Based on the descriptions above, total PAR estimated in a hypothetical breach of the reservoir in the order of 15 (Appendix B).

Other time periods could be considered for this PAR assessment (e.g., summer night-time, winter daytime and winter night-time) in accordance with the recommendations of Veale et al (2019) but the summer daytime period discussed above provides the most conservative estimate of the PAR.

Table 8: Determination of Dam's Potential Impact Classification (reproduced from Schedule 2 of the Building (Dam Safety) Regulations 2022)

Assessed damage level	Population at Risk (PAR)				Potential Loss of Life
	0	1 to 10	11 to 100	More than 100	
Catastrophic	High	High	High	High	No persons
	N/A (see Note 1)	High	High	High	One person
	N/A (see Note 1)	High	High	High	Two or more persons
Major	Medium	Medium	High	High	No persons
	N/A (see Note 1)	Medium	High	High	One person
	N/A (see Note 1)	High	High	High	Two or more persons
Moderate	Low	Low	Medium	Medium	No persons
	N/A (see Note 1)	Medium	Medium	Medium	One person
	N/A (see Note 1)	High	High	High	Two or more persons
Minimal	Low	Low	Low	Low	No persons
	N/A (see Note 1)	Medium	Medium	Medium	One person
	N/A (see Note 1)	High	High	High	Two or more persons

Notes associated to Table 8

1. Not applicable. Population at risk is zero therefore no potential loss of life.

Supporting Information to Table 8 (from Section 3 of the Building (Dam Safety) Regulations 2022)

- *Population at Risk (PAR) means:* the number of people likely to be affected by an uncontrolled release of all or part of the stored water or other fluid due to a failure of the dam (assuming that no person takes any action to evacuate)
- *Potential Loss of Life means:* the number of people expected to lose their life as a result of an uncontrolled release of all or part of the stored water or other fluid due to a failure of the dam.

3.9 Potential Loss of Life

No formal estimates of potential loss of life have been carried out as part of this “intermediate: level assessment. However, the PAR consists of temporary populations either in or near the Ōhau River or the Gladstone or Kimberley Reserves at the time of hypothetical dam failure event.

In general, the areas downstream of the dam are sparsely populated with no permanent, residential dwellings flooded to a depth greater than 0.5 m. The rapidly rising river and floodplain levels in a hypothetical dam break flood in the Ōhau River Reserve areas and in other inundated areas, coupled with some possibility of a notice to evacuate provided by the dam owner, should provide some warning of a potential flood hazard to users of the reserves, roads or river areas. Although there is potential for loss of life, particularly if there are large number of people camping at the Kimberly Reserve area near the water’s edge, it is not expected that a life would be lost.

3.10 Potential Impact Classification

Using a damage level of “moderate” and a PAR of 1, and no expected Potential Loss of Life, Table 8 indicates the POC for the proposed Poads Road reservoir is **Medium**.

Note that even if the assessed PAR were significantly higher than 15 but less than 100, or if the potential loss of life was assessed to be one person, Table 8 indicates that the PIC classification for the reservoir would still be **Medium**.

4.0 Geology, Hydrogeology and Geotechnical Interpretation

4.1 Introduction

The reservoir site is on an alluvial terrace bounded to the east and south by the foothills of the northern Tararua Range and north across the Ōhau River (Figure 5). Each of the terraces is relatively level but the highest is at the site's southern boundary. The other terraces step down to the north until they meet the Ōhau River, beyond the boundary of the reservoir site.

There is an overall fall across the ground profile from southwest to northeast. Running approximately South to North across the site there is approximately 1 m fall for each 35 m horizontal distance from the terrace toe near Poads Road (~128 m RL) to the top of the Ōhau River terrace at approximately 119 m RL.

Ground profile is flatter along a section from the southeast to northwest, but the ground generally slopes parallel with the direction of the Ōhau River.

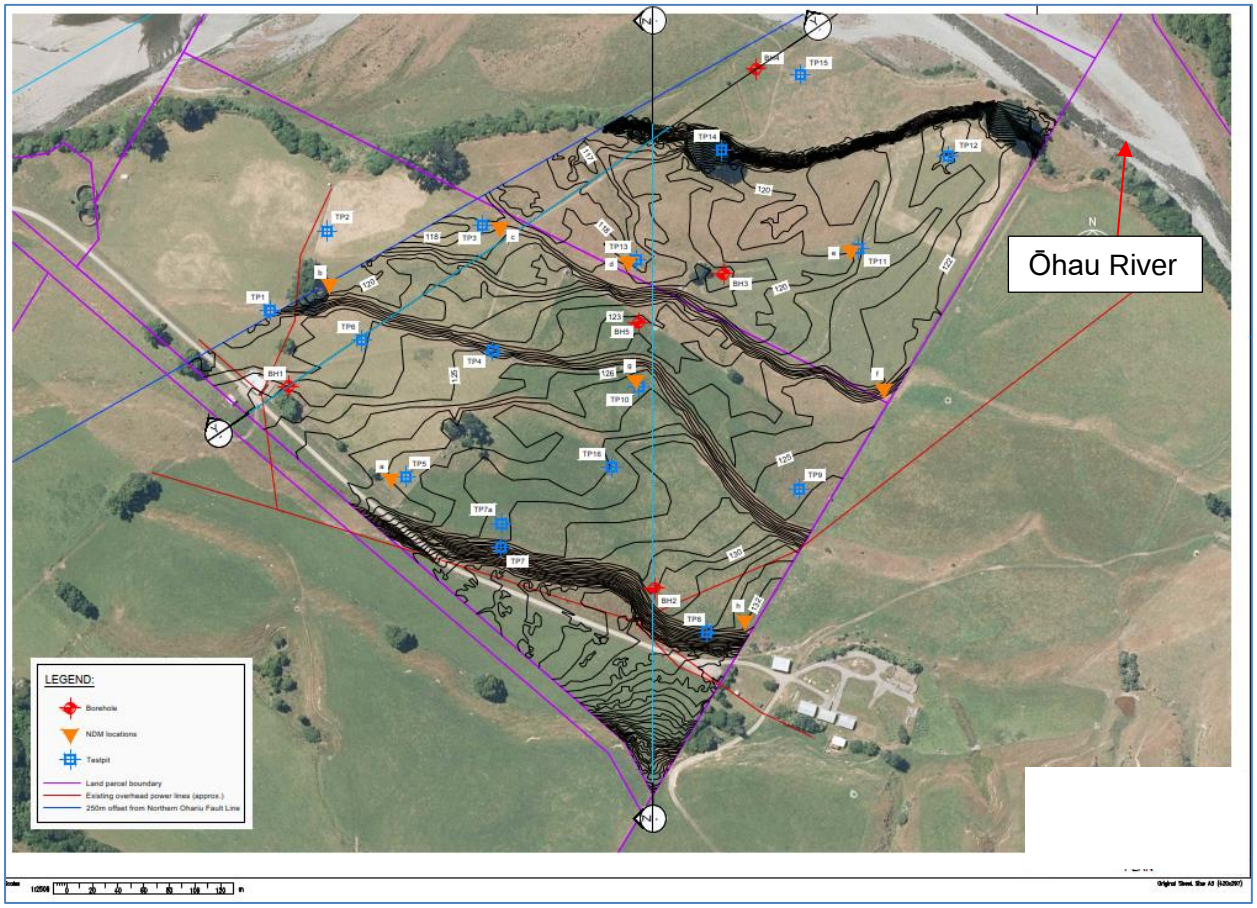


Figure 5: Site Investigation Plan

4.2 Regional Geology

The site bounded to the east and south by the foothills of the northern Tararua Range and north across the Ōhau River. The area to the north, east and west is predominantly Rakaia Terrane sandstone-mudstone sequences.

Structurally, the New Zealand Active Faults Database (GNS, 2022) indicates an active fault running along the alignment of the Ōhau River and the Makahika Stream near the site, called the Northern Ōhāriu Fault. Faults are discussed in more detail in Section 5.2.

The site is characterised by the alluvial terraces of Quaternary sediments at the surface, highest at the southern site boundary before stepping down a series of terraces to the north where it meets the Ōhau River.

The site is underlain by Ohakean aggradational gravels of Late Pleistocene age (Q2a) and older alluvium comprising silty CLAY. These sediments are typically poorly sorted to well sorted gravels.

4.3 Flood Hazard

The site is on the left bank of the Ōhau River upstream of the constriction at the Poads Road bridge and upstream of the confluence of the Makahika Stream. The lowest area of the site is in the northeast, which is approximately 118 m RL. The Horowhenua District Council flood risk map suggests in flood events water backs up from the Poads Road bridge into the wide section of flood plain opposite the reservoir giving a nominal flood water level of 118 m RL in the river at the north-eastern boundary of the site.

This flood level governs the potential lowest level of works and particularly the toe of the reservoir embankment.

The lowest perimeter of the embankment will be provided with additional protection against flood waters by constructing the access road around this north-eastern corner of the site.

4.4 Geotechnical Investigation

Characterisation of the site ground conditions is based on site inspections and a geotechnical investigation completed in 2021 (Damwatch, 2021) comprising:

Trial pits: Seventeen Trial pits across the site to a maximum depth of 4 m below ground level (bgl) completed by Higgins.

Sonic cored boreholes: Five sonic cored boreholes across the site to depths between 10m and 30.5m bgl completed by Pro-Drill.

Nuclear Density (NDM) Testing: NDM tests at eight locations across the site at depths between 0.5 and 0.7m bgl completed by Fulton Hogan.

Standpipe piezometers: Two boreholes are installed with standpipe piezometers and temporary groundwater level loggers deployed to measure groundwater levels.

Shear Wave standpipe: One borehole is installed with solid standpipe for downhole shear wave. Downhole shear wave testing completed by A J Sutherland.

4.5 Laboratory Testing

Selected bulk samples were retained from the test pits and boreholes during the 2021 investigation and sent for subsequent laboratory testing. Laboratory testing: Material classification testing completed by Opus Laboratories.

The following laboratory testing programme was adopted based on findings of the investigations:

- 13 Particle Size Distribution (PSD) (NZS 4402:1986, Test 2.8.1), - oversize material was estimated and removed from samples prior to delivery of samples.
- 4 Hydrometer with particle size distribution (NZS 4402:1986, Test 2.8.1 & 2.8.4).
- 4 Atterberg limits (NZS 4402:1986, Tests 2.1 - 2.5).
- 6 Compaction tests (NZS 4402:1986, Test 4.1.2 (heavy)).
- 1 crumb dispersion test (ASTM D6572-21).

The Particle Size Distributions of samples including hydrometer results for all soils samples tested (Figure 6).

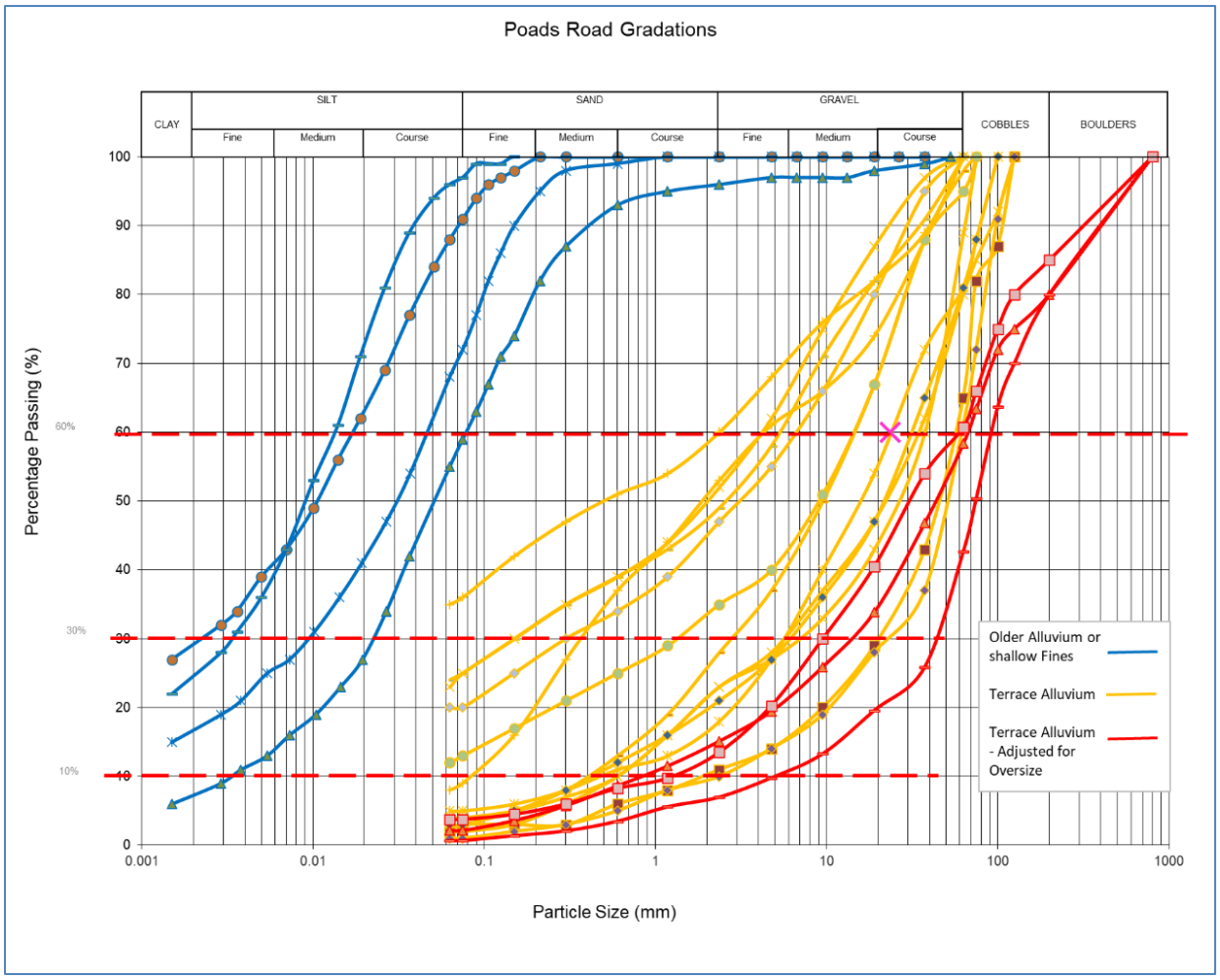


Figure 6: Investigation PSD and Hydrometer Results

4.6 Engineering Geology Model

Four general soil units were encountered in the test pits and boreholes and are described as:

- Topsoil. Topsoil occurs across the site and is about 0.2 to 0.4m thick.
- Terrace Alluvium. The Terrace Alluvium underlies the topsoil and extends 5.5 to 19.0 m below ground level (~102.2 m RL to 114.6 m RL). Typically, gravel dominates the

alluvium samples from the test pits (Figure 5). However, the fine contents of samples retrieved from boreholes tend to be higher than in the samples from test pits. Differences in the alluvium's composition is attributed to differing energy environments of old river channels during deposition and incising of terraces.
    - Shallow – up to 3.0 – 4.0m below ground level.
    - Deeper - There is an increase in fines below the shallow terrace alluvium.
- Older alluvium. Older Alluvium was encountered below the Terrace Alluvium and is possibly of estuarine or lacustrine origin. The deposit is understood to be several thousand years older than the Alluvial Terrace and deposited in different environmental conditions.

Figure 7 below presents the subsurface profile of the site from South to North, which is an interpolation of borehole data, test pit data, and ground profile.

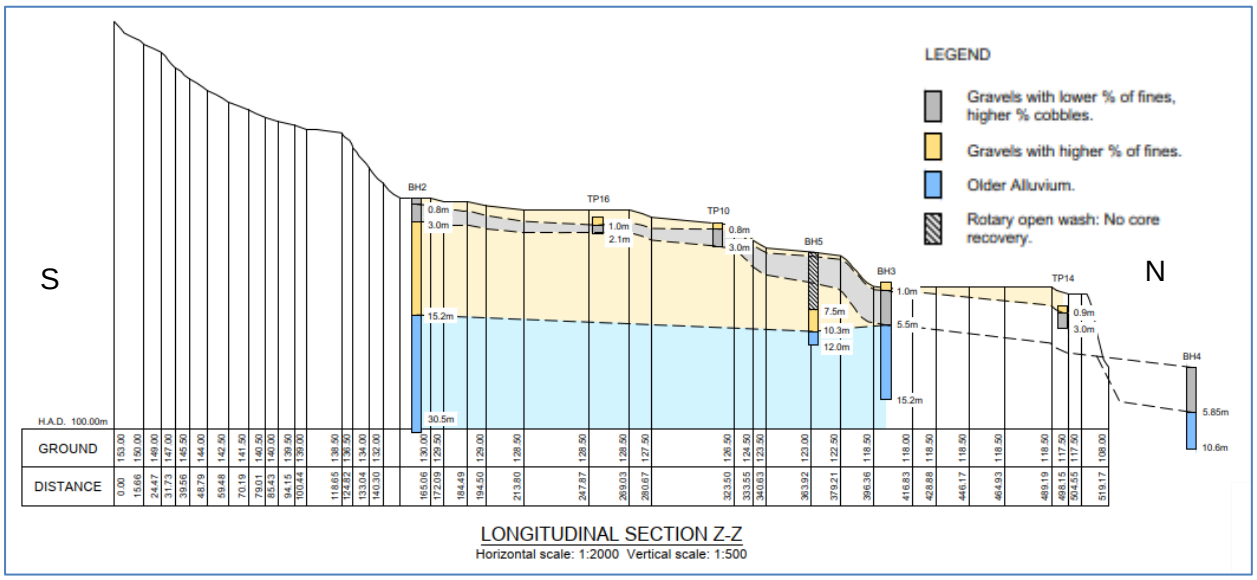


Figure 7: Geological Cross Section - Section Z - Z (Figure 3 for Location)

4.6.1 Topsoil

The topsoil across the site is generally non-plastic, gravelly cobbly silty SAND with organics in the form of rootlets. This topsoil will not be used as an engineering material, but some topsoil stripped from the reservoir's footprint will be retained for placing over the outside face of the main embankment.

4.6.2 Terrace Alluvium

The terrace alluvium consists of GRAVEL with varying percentages of sand, fines, cobbles and boulders. In addition, the alluvium is dense, based on in situ shear wave measurements and the Nuclear Density (NDM) testing.

The maximum particle size ranged between 500 mm and 800 mm diameter, and the percentage of these larger particles varies across the site. The shallow alluvium includes layers of sandy clay and sandy silt, which are typically not continuous and less than 600 mm thick (Test pits TP7, TP7a, TP10 and TP15 at depths less than 2.6 m).

- The average shear wave velocity measurements are summarised as:
  - Shallow 359 m/s.
  - Deep 726 m/s.
- The NDM testing within the shallow deposit measured:
  - Moisture content 6.1 – 29.65%.
  - Dry density 12.9 – 18.6 kN/m^3.
  - Bulk density 16.3 - 19.7 kN/m^3.

The results of falling head tests in BH01 and BH03 provide an indication of possible permeabilities at shallow depths in the terrace alluvium. Both boreholes partly penetrated the permeable stratum and the Hvorslev (1951) analysis results suggest permeabilities spanning about 2 orders of magnitude. The results and interpretation suggest:

- The alluvium is dense with permeabilities possibly between 3 x 10^{-7} and 9 x 10^{-8} m/s.
- The permeability is likely to be anisotropic.

Several laboratory tests results provide the basis for charactering the deposit. The particle size distributions are adjusted to account for oversized proportions of cobbles and boulders (estimated and recorded in the field).

Two soils classification systems provide different perspectives on the soil's origin and behaviour, the New Zealand Geotechnical Society system (NZGS, 2005), and the Unified Soil Classification System (ASTM).

Under the New Zealand Geotechnical Society Standards (NZGS) the alluvium, including adjustments for oversize particles, is summarised by generic particle size descriptions (Table 9):

- The alluvial deposit classifies as a well graded gravel with sand (GW).
- The finer lenses classify as Sandy Lean CLAY (CL).

Table 9: Terrace Alluvium Summary (NZGS Classification)

Particle description	Alluvium	Finer lenses
Cobbles and Boulders	0 - 57%	0%
Gravel	36 - 70%,	0 - 4%
Sand	6 - 45%,	32 - 41%
Fines.	1 - 35%	27 – 28% - Silt
		27 - 41% - Clay

The Unified Soil Classification System (USCS) (ASTM) is correlated against engineering properties and behaviour. This system is the basis for assessing the soil's engineering behaviour.

Table 10: Terrace Alluvium Particle Summary (USCS Classification)

Particle description	Alluvium	Finer lenses
Cobbles and Boulders	0 - 50%	0%
Gravel	32 - 83%	0 - 3%
Sand	13 - 52%	28 - 38%
Fines.	1 - 36%	59-72%

In this system USCS:

- The alluvium is classified as a well to poorly graded gravels (GW, GP) to silty gravels (GM) and sand (SM). Also, the deposit is non-dispersive - Grade ND1 (ASTM D6572-21 crumb dispersion test).
- The finer layer is classified as sandy Lean clay (CL) and silt (ML). Also, the plasticity index of the fines is 7 and 8.

Table 11: Unified Soil Classification System (USCS)

Particle size distribution (PSD)					Fraction retained on sieve size (%)			
					>75 mm	> 4.75 mm	> 0.075 mm	<0.075 mm
PSD	ID (Depth)	LL	PI	Class	Cobbles & Boulders**	Gravel	Sand	Fines
1	TP3 - 2.3m			GP	18.0	82.9	13.4	3.7
2	TP4 - 3.1m			GW	15.0	67.1	28.2	4.7
3	TP6 - 0.5m			SP SM	0.0	39.0	52.0	9.0
4	TP7 - 1.8m			GW	0.0	63.0	34.0	3.0
5	TP10 - 1m			GW	12.0	69.3	27.3	3.4
5*	TP10 - 1m			GW	36.6	69.3	27.3	3.4
6	TP11 - 1.1m			GP	28.0	80.6	18.1	1.4
6*	TP11 - 1.1m			GP	49.6	80.6	18.1	1.4
7	TP11 - 0.7m			GW	0.0	73.0	25.0	2.0
8	TP13 - 2.1m			GP GM	12.0	69.3	25.0	5.7
8*	TP13 - 2.1m			GP GM	34.0	69.3	25.0	5.7
9	BH1: 2.7 - 5.0m			GM	0.0	60.0	27.0	13.0
10	BH1: 7.0 - 7.5m			GM	0.0	32.0	32.0	36.0
11	BH1: 12.0 - 13.7m			GM	0.0	42.0	33.0	25.0
12	BH2: 3.0 - 5.2m			GM	0.0	45.0	35.0	20.0
13	BH2: 6.7 - 8.1m			GM	0.0	38.0	37.0	25.0
Shallow finer layer								
14	TP7a: 1.4m	34	7	ML	0.0	3.0	38.0	59.0
15	TP15: 2.2m	30	8	CL	0.0	0.0	28.0	72.0
Older Alluvium								
16	BH2: 20.2 - 20.8m	28	8	CL	0.0	0.0	9.0	91.0
17	BH3: 5.5 - 6.4m	38	15	CL	0.0	0.0	9.0	91.0

*Adjusted PSD to account for oversized cobble and boulder
** Percentage of material greater than 75 mm of the entire sample
*** Gravel, Sand, and fine percentage based on material passing the 3-in. (75 mm) sieve. Sum 100%

4.6.3 Older Alluvium

The Older Alluvium was encountered in all boreholes and typically consists of stiff to very stiff silty CLAY with thick lenses of tightly packed silty / clayey sandy GRAVEL. Wood fragments were encountered, often within the clay portions of the material.

Laboratory testing undertaken on the fine portion of the Older Alluvium included two PSDs, two hydrometer tests, and two Atterberg tests.

Under the USCS system the finer soils of the Older Alluvium classify as lean clay (CL) based on the PSDs and Atterberg limits tests. These samples consist of 0% gravel, 9% sand and 91 % fines. The fines have a Plasticity Index between 8 and 15 (Figure 8).

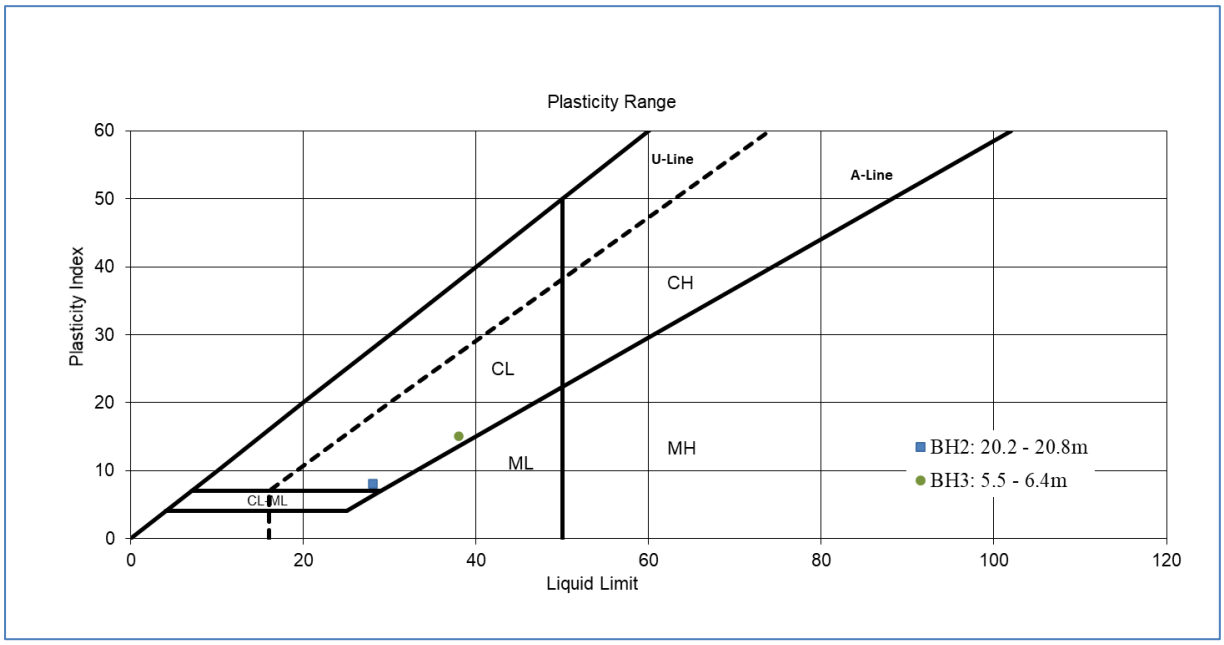


Figure 8: Older Alluvium Atterberg limits

The shear wave measurements of the Older Alluvium indicate that it is dense, with shear wave velocities ranging from 338 m/s to 769 m/s (average 445 m/s).

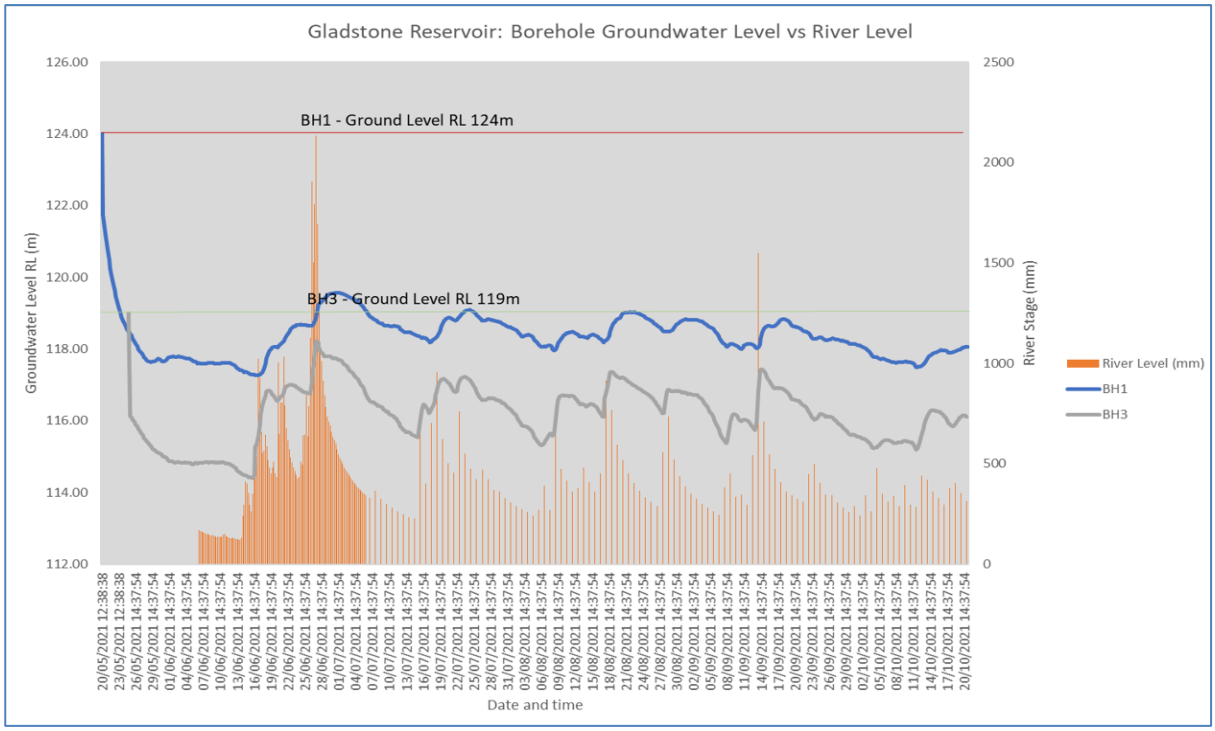
4.7 Groundwater

Groundwater level has been measured in trial pits and boreholes. During the site investigation, groundwater was observed in Boreholes BH1, BH2 and BH3.

- Borehole BH1 - Water was approximately 10.2 m bgl after the hole was drilled to a depth of 25.9 m bgl.
- Borehole BH2 – Water was approximately 7.35 m bgl when the base of the hole was at 30.5 m bgl. Groundwater observations whilst drilling the boreholes were complicated by using water as a drilling medium.
- Borehole BH3 - Water was at approximately 2.75 m bgl.

Figure 9 shows the groundwater levels recorded in BH1 and BH3 along with the Ōhau river level. After the initial settling period:

- BH1 - Groundwater varied between 116.24 m RL and 119.58 m RL (7.76 – 2.26m bgl).
- BH3 – Groundwater varied between 114.12m RL and 118.55 m RL (4.88 – 0.45m bgl).



Note: Time series of flow is derived by applying a rating (a curve, calculation, or table) that expresses the relation between the measured stage and the discharge in an open channel or conduit at a given cross-section.

Figure 9: Groundwater records for BH1 and BH3

The maximum excavation depth for the construction of the reservoir is 118 m RL. Consequently, given the piezometric level in BH 1 has historically risen to 119 m RL:

- Groundwater is expected to be encountered during excavation and construction of the reservoir.
- Groundwater collection and control measures are necessary across the base of the reservoir to prevent hydraulic uplift below the reservoir's basal river system.

4.8 Geotechnical Properties

Characteristics of site soils are developed from results of the laboratory (PSD, hydrometer, Atterberg limits, compaction) and in-situ test results (shear wave velocity and permeability). Shear strengths of the embankment materials and foundation soils are based on literature for soils with similar geologic and material characteristics to those at the site.

Table 12 lists the geotechnical properties adopted in stability assessments.

Unit weight of the bulk fill is based on laboratory compaction tests and 95% of optimum.

The bulk fill shear strengths are stress dependent based on the relationship for gravels by Terzaghi, Peck and Mesri (1996). This relationship is consistent to the stress dependent relationship by Wong and Duncan (1974) for well graded and poorly graded gravels (GW and GP) such as the bulk fill. The stress-dependent shear strength criterion was used to account for the bulk fill being a well-compacted granular soils (gravels and cobbles) and the embankment confining stresses.

Under aftershock and post-earthquake static conditions, a 10% reduction in shear strength is applied to the embankment materials (bulk fill, filter and drain) to reflect potential degraded strength resulting from the mainshock SEE ground shaking. The foundation is dense to very dense terrace deposits are not expected to experience loss of shear strength.

Table 12 Summary of geotechnical properties

Material Zone	Unit weight	Long-term (steady state seepage)		OBE and SEE		Aftershock and Post-earthquake static	
		Friction angle	Cohesion	Friction angle	Cohesion	Friction angle	Cohesion
	kN/m^3	(Ø') deg	(c') kPa	(Ø') deg	(c') kPa	(Ø') deg	(c') kPa
Bulk Material	22	ϕ-$\Delta\phi$log(s'$_n$/p$_a$)*	0	Same as long -term		ϕ-$\Delta\phi$log(s'$_n$/p$_a$)**	0
Drainage	21	42	0	Same as long -term		39	0
Filter	21	38	0	Same as long -term		35.1	0
Topsoil	20	35	0	Same as long -term		35	0
Alluvium Terrace (upper)	22	42	0	Same as long -term		42	0
Alluvium Terrace (lower)	22	42	0	Same as long -term		42	0
Older alluvium	18	25	50	0	120	0	120

*Approximate correlation to Terzaghi, Peck and Mesri stress dependent function with ϕ = 42° and $\Delta\phi$=8°
**10% reduction applied to stress dependent function

5.0 Seismicity

5.1 Introduction

The region around the reservoir site is seismically active. Figure 10 shows regional active faults that contribute to the site's seismic hazards. Specifically, there is the Wellington Fault, Northern Ōhāriu Fault and the Hikurangi Subduction Zone.

- The Wellington Fault can generate a magnitude (M_w) 7.5 earthquake and has a recurrence interval of 830 years (GNS Science, 2012). It is located approximately 14.5 km from the site.
- The Northern Ōhāriu Fault can generate a magnitude (M_w) 7.2 – 7.5 (Palmer & Van Dissen, 2002) and has a recurrence interval of 2,600 years (GNS Science, 2012). It is located less than approximately 500 m from the site.
- The Hikurangi Subduction Zone contributes significantly to the region's seismic hazards (Cubrinovski, Bradley, Wentz, & Balachandra, 2022; Bradley, Cubrinovski, & Wentz, 2022). The Hikurangi Subduction Zone can generate a magnitude (Mw) 8.2 - 9.0 earthquake and has a recurrence interval of 850-6700 years. It is located approximately 100 km to the east, off the coast of the North Island and approximately 30-50 km below the site.

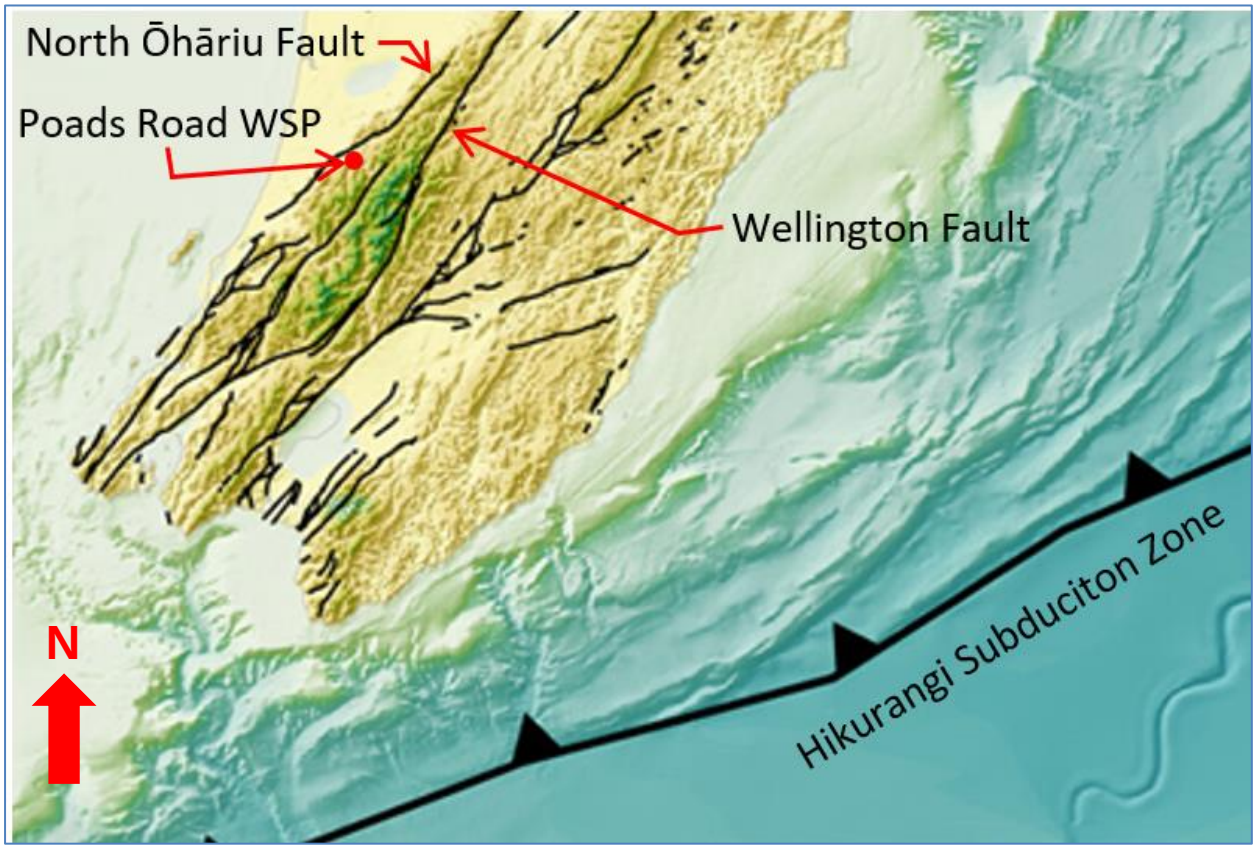


Figure 10: Regional active faults

Figure 11 shows the nearby mapped active faults (GNS, 2022). Details of these faults are listed in Table 13.

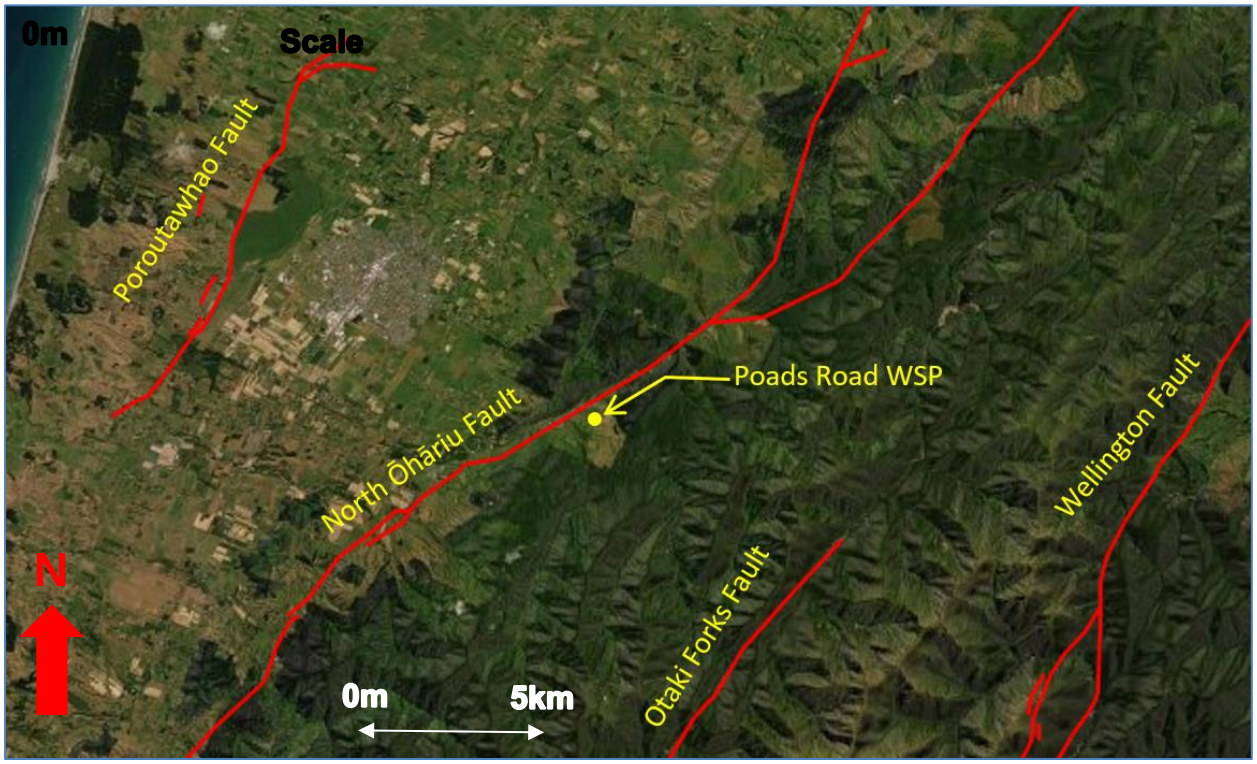


Figure 11: Area active faults (GNS, 2022)

Table 13: Nearby Mapped Active Faults

Fault	Estimated Distance (km)	M_w	Recurrence Interval (yr.)
Northern Ōhāriu	< 0.5	7.4	2,600
Otaki Forks	7.2	unknown	3,500-5,000
Poroutawhao	10.9	6.8	5,100
Wellington	14.5	7.3-7.5	710-850

5.2 Seismic Hazards

Figure 12 illustrates the active faults mapped near the reservoir site. The closest active fault is the Northern Ōhāriu Fault.

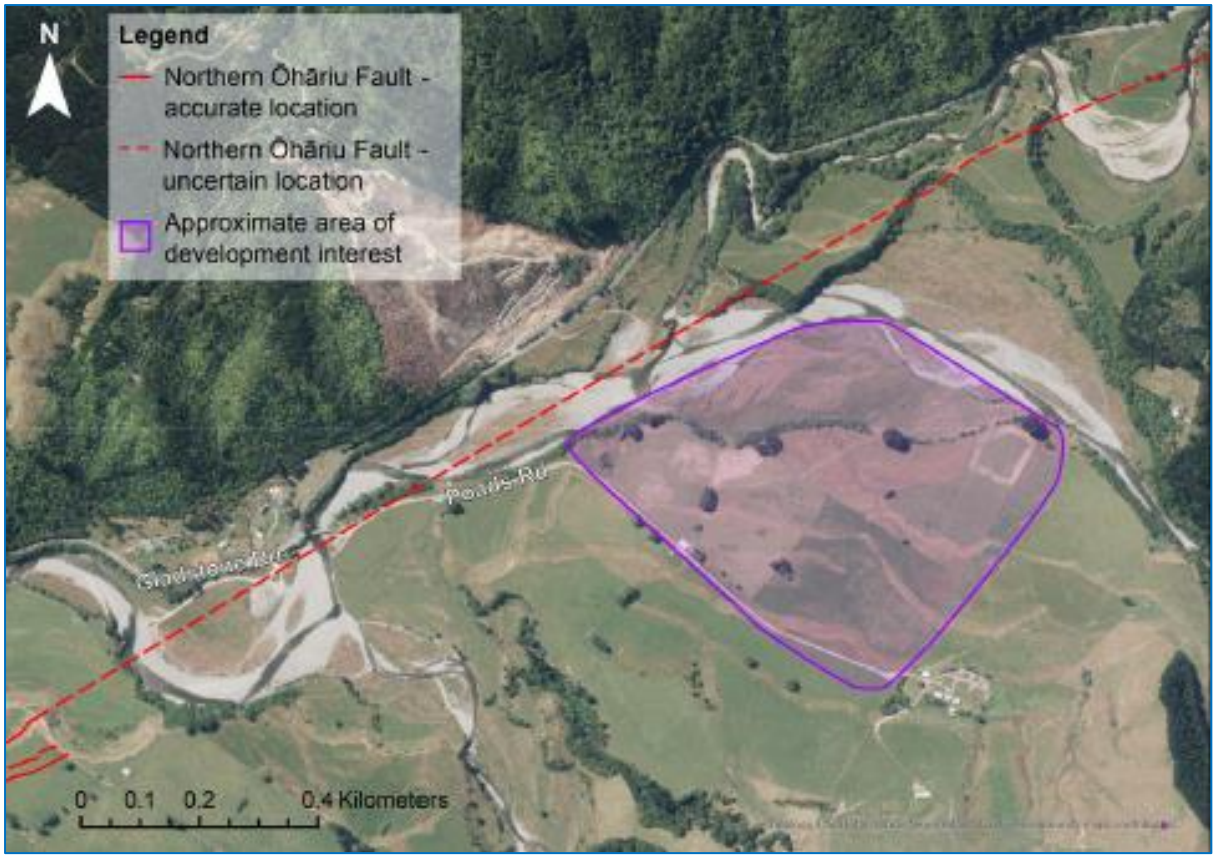


Figure 12: Northern Ōhāriu Fault (GNS, 2022)

GNS provides the following characterisation of the Northern Ōhāriu Fault (GNS, 2022):

> *"The Northern Ōhāriu Fault extends for ~60km from the south of Ōtaki up and along the western edge of the Northern Tararua range. It is considered to be the northern extension of the Ōhāriu Fault that extends from the southern coast of Wellington to north of Waikanae* (Palmer & Van Dissen, 2002)*. Together, the Ōhāriu and Northern Ōhāriu faults cover a distance of over 130 km and make up a major active strike-slip fault system that poses earthquake shaking and ground-surface rupture hazard along the Kāpiti Coast and Horowhenua District.*
>
> *The Northern Ōhāriu Fault has been classified as a Recurrence Interval Class II (RIC II) fault, meaning that it ruptures every 2000 – 3500 years* (Van Dissen & Heron, Earthquake Fault Trace Survey, Kapiti Coast District., 2003) (Van Dissen, Heron, Hinton, & Guerin, 2004) (Langridge & Morgenstern, 2019)*.*
>
> *The most recent event on the fault occurred between several hundred and thousands of years ago, with a net surface displacement of 3 – 4m* (Palmer & Van Dissen, 2002)*.*
>
> *The location of the Northern Ōhāriu Fault over most of its length has been well constrained through previous mapping studies and with the collection of Light Detection and Ranging (LiDAR) data* (Van Dissen & Heron, 2003; Van Dissen, Heron, Hinton, & Guerin, 2004; Langridge & Morgenstern, 2019)*. However, its location around the Poads Road Water Storage Reservoir and along much of Gladstone Road is uncertain due to young alluvial cover sediments that have eroded away and/or buried recent evidence of fault rupture (i.e. fault location)."*

5.3 Local Reconnaissance

As part of the feasibility design study GNS undertook further field mapping with the intention of identifying exposures of the Northern Ōhāriu Fault within the zone of the previously mapped but poorly constrained location of the fault. No direct outcrop identification of the Northern Ōhāriu Fault was identified in this field mapping exercise. However, mapping of bedrock exposures and alluvial terraces at similar elevations assisted in inferring the fault location and placing broad bounds to its location.

5.4 Seismic Performance Criteria

The NZDSG provide performance criteria for dam design under seismic loading. Dams are to be designed for two levels of earthquakes as follows:

- **Operating Basis Earthquake (OBE).** The OBE is the minimum seismic ground motion for evaluating the dam performance. It applies to all dam Potential Impact Categories. The OBE is often represented by 1:150 Annual Exceedance Probability (AEP) ground motions. Where the reservoir is required to support a post-earthquake function a higher standard of 1:500 AEP is often adopted. The OBE post-earthquake performance requirement is for the dam embankment to remain operational although minor repairable damage is permitted, for instance the displacement of riprap on the internal face of the embankment.
- **Safety Evaluation Earthquake (SEE).** The SEE is the maximum ground motion adopted when evaluating a dam's design, which is dependent on the dam's PIC. Performance criteria under the SEE requires that there be no uncontrolled release of the impounded water and damage must not lead to catastrophic failure. For a Medium PIC dam, the SEE ground motion should be estimated at the 50th to 84th percentile level of the Controlling Maximum Earthquake (CME) if developed by a deterministic approach and need not exceed the 1:2,500 AEP ground motions developed by a probabilistic approach.

For the feasibility design of the Poads Road reservoir the OBE and SEE are represented by the 1:500 AEP and 1:2,500 AEP ground motions, respectively.

5.5 Seismic loads - Mainshock

Ground motions for the SEE and OBE (Table 14) are obtained from Earthquake Engineering Practice Module 1, Overview of the Guidelines (MBIE, 2021), which is under Section 175 of the Building Act 2004. The guidelines provide interim probabilistic Peak Ground Acceleration (PGA) and earthquake magnitude (M_w) for the period while the New Zealand National Seismic Hazard Model (NSHM) was being revised and subsequent design standards including the Dam Safety Guidelines incorporate the revised NSHM.

Ground motions provided in the Module 1 Guidelines supersede NZS1170.5 (NZS, 2004) (and the Bridge Manual (NZTA, 2013) for six areas where the Hikurangi Subduction Zone (HSZ) contributes significantly to the seismic hazards. Palmerston North including Levin is one of these areas.

5.6 Seismic Loads - Aftershock

For high value assets such as the Poads Road reservoir, aftershock loading following the SEE mainshock should be considered (NZDSG). When assessing dam stability, the aftershock loading is assumed to be one magnitude less than the CME and anticipated to occur within one day of the SEE.

The CME for the site is not defined. However, local faults have a potential magnitude of Mw 7.5. Therefore, the aftershock is taken as a magnitude Mw 6.5 earthquake.

Module 1 Guidelines does not provide ground motions associated with aftershock loading. Therefore, the aftershock PGA is estimated using Pacific Earthquake Engineering Research (PEER) NGA West 2 horizontal Ground Motion Prediction Equations (GMPEs) (PEER, 2015) Excel® workbook. The workbook implements five GMPEs for shallow crustal faults, either individually or with assigned weighting, to develop deterministic response spectrum.

The approach calibrates the fault and site inputs to match the SEE mainshock PGA and then use these inputs to estimate the aftershock PGA by changing the earthquake magnitude M_w from to 7.5 to 6.5 to obtain aftershock PGA. Various combinations of GMPEs, shear wave velocity over the 30 m depth (V_{s30}) and distance are considered when obtaining the best fit parameters. The best fit parameters to obtain reasonable mainshock and aftershock PGAs used equal weighting of the Chiou & Youngs (2014) and Idriss (2014) GMPEs and a fault distance of 10 km. Using these parameters, the mainshock and aftershock PGAs at the 84th percentile were 1.0 g and 0.68 g, respectively. These aftershock estimates are in general agreement with the studies for the Wellington Fault (GNS Science, 2014).

Thus, the feasibility design adopts an aftershock PGA of 0.68 g (Table 14).

Table 14 Design Seismic Loads for Poads Road

Earthquake	PGA (g)	M_w	Estimated Distance (km)
OBE (1:500AEP)	0.55	7.5	
SEE (1:2,500AEP)	1.00	7.5	10
Aftershock	0.68	6.5	10

5.7 Seismic Assessment Limitations

Module 1 Guidelines provides preliminary ground motions for use in the feasibility design of Poads Road WSR. However, there is uncertainty in the role of the Northern Ōhāriu Fault has to the site's mainshock and aftershock loading. Additionally, response spectrum are not provided by Module 1 Guidelines and PGAs provided in the Module 1 Guidelines are not compatible with methods outlined in the Bridge Manual.

5.8 Revised NZ National Seismic Hazard Model 2022 (NSHM22)

In October 2022, a revised NSHM was released by a research programme led by GNS Science. The following are some key points regarding the NSHM22 and the significance for the Poads Road WSP feasibility design:

- The NSHM22 is a major revision of the 2010 model and represents the best international state of practice for the assessment of earthquake hazards.
- Ground motions have typically increased on average by 50% across New Zealand, and this is the case for the site.
- Seismic hazards in New Zealand have not changed, rather our understanding of the hazard has changed.
- The NSHM assists in assessing the uncertainties in seismic hazards, but currently (early 2023) it is not a standard for design actions and should not be used as such.
- There is currently no change to the NZDSG for the design of dams and Module 1 Guidelines are the current design standard for geotechnical engineering practice.
- How the ground motions from the NSHM22 will be considered in the future updates of the NZDSG and Building Code is unknown and will take time.
- MBIE has commenced a programme of work to develop Building Code updates related to seismic risk and the 2022 NSHM. Consultation on changes is anticipated in mid-2023. A representative of NZSOLD is part of this working group.
- The overarching principle for good design is to consider and address seismic hazard uncertainties. Designs should incorporate robust and resilient measures to manage the risks.

The GNS Science on-line tool for the NSHM22 provides probabilistic ground motions and the inputs are the site location and V_{s30}. The tool outputs are seismic hazard curves and response spectrum at mean and at the 80% and 90% confidence bounds. Deaggregation information is also provided for selected V_{s30} and cities including Levin. However, the tool does not provide deterministic ground motions. Therefore, developing deterministic ground consistent with the NSHM22 inputs is not straightforward.

Borehole BH2 provides a V_{s30} of 476 m/s. The NSHM22 tool provides Peak Ground Accelerations (PGA) for V_{s30} values either side of the BH2 value (Table 15). The difference in estimated PGAs for the two AEP are small, but the magnitude is significantly higher that the methods currently used to develop the seismic loads for the reservoir.

Table 15: Seismic loads per the NZ NSHM22 at Poads Road WSR

Vs30 (m/s)	450	500
AEP	PGA (g)	
1:500	0.89	0.88
1:2,500	1.74	1.77

The following are recommended for the detailed design of the reservoir and its embankments:

- Perform sensitivity analyses to estimate possible the ground motions derived from the NSHM22 and include robust and resilient measures to address uncertainty in the seismic hazards.
- Undertake a site-specific seismic hazards assessment (SSSHA) to develop deterministic ground motions for the Credible Maximum Earthquake (CME) and the related aftershock. Then assess whether an adjustment to the probabilistic NSHM22 ground motions is appropriate. The SSSHA should be performed by an expert able to incorporate and develop deterministic ground motions consistent with NSHM22. Such a study will assist in understanding the role of the Northern Ōhāriu Fault on the site's seismic hazards. Resulting response spectra can then be used in assessing the embankment and structures seismic performance.

A key input for developing ground motions is the V_{s30} value and additional values should be obtained as part of detailed design to understand the spatial variability over the site.

5.9 Foundation Liquefaction Potential

Liquefaction is the sudden loss of shear strength in saturated cohesionless soils due to the generation of excess porewater pressure caused by earthquake shaking. Liquefaction of loose soils or inadequately compacted embankment fill can cause settlement or lateral spreading, which if significant, may lead to dam failure.

The procedure for a preliminary assessment of the liquefaction hazard is set out in Module 3 Guidelines (MBIE, 2021). A simplified assessment uses semi-empirical methods and results of the in-situ shear wave velocity, which for the site is represented by measurements in Borehole BH2. The Module 3 Guidelines approach for a simplified assessment includes the following steps:

1. Site characterisation (Section 4.4) and seismic hazard evaluation (Section 5.2).
2. Liquefaction susceptibility screening.
3. Liquefaction initiation or triggering assessment.
4. Liquefaction-induced ground deformations.
5. Consequences assessment.

The following sections discuss steps 2 to 5 of the simplified liquefaction assessment.

5.9.1 Liquefaction susceptibility screening

Screening for liquefaction susceptibility is an initial step in any assessment. It is based solely on geological criteria and soil compositional criteria. The soils at the site are fluvial deposits. Although the site's stress history through sea level changes and deposition/erosion of surface materials is unknown, the geology of the deposits is described as:

- Riverbed deposits are recent Alluvium (Q1a) of Holocene age (<10,000 years) and could be susceptible to liquefaction. Parts of the intake structures, the infiltration galleries, are to be constructed within this recent alluvium. However, these infiltration galleries are flexible and surrounded by high permeability materials, all of which can be readily repaired and re-commissioned. For these reasons this deposit needs no further assessment for the feasibility design.

- Alluvial Terrace is of Late Pleistocene age Ohakean aggradational gravels (Q2a). These are inherently resistant to liquefaction due the geologic age and its consolidation. However, the composition consists of:

    - Sandy gravels with fines content varying from 1% to 36%, average 12% (Damwatch, 2021).
    - Thin fines layers with a PI between 7 and 8, although no thin fines layers were encountered in Borehole BH2.
    - Typically exhibits 'sand-like' behaviour.

  Thus, the geological age suggests the alluvial terrace deposits are resistant to liquefaction, but composition of sandy gravels suggests they may be susceptible to liquefaction and in addition there are non-continuous thin fines layers which are potentially susceptible to liquefaction.
  Thus, these sandy gravels require further assessment of liquefaction potential.

- The underlying Older Alluvium is older and probably of early Pleistocene age. These deposits are more resistant to liquefaction than the Alluvial Terrace deposits. The deposit consists of layers of CLAY, silty/clayey SAND and sandy GRAVEL to GRAVEL. The Older Alluvium in Borehole BH2 include interbedded clays and gravels between 21 m and 25 m depth. The thickness of the clay and gravel layers range from 0.2 m to 0.9 m. Similar interbedding was encountered in Borehole BH4.The composition assessment suggests:
    - The clay layers with a Plasticity Index between 8 and 15 and a very low Liquidity would not lose a large proportion of strength when disturbed by earthquake motions (it is a clay with a low sensitivity to strains).
    - The Older Alluvium clay with higher plasticity (Plasticity Index greater than 12) exhibits 'clay-like' behaviour and not susceptible to liquefaction.
    - The Older Alluvium with low plasticity (Plasticity Index of 8) are sand-like and potentially susceptible to liquefaction.
    - The sandy gravels are sand-like and susceptible to liquefaction.

When evaluating the possible consequences of liquefaction or cyclic softening, it is necessary to consider the effects of the site's response. In particular, will the liquefied or cyclic softened critical layer(s) directly and indirectly interact together, and interact with adjacent non-critical

layers. These interaction affects how deformations evolve and are expressed at the ground surface. Continuous critical layers can generate more severe displacement, whereas interbedded layers tend to perform better with either reduced effects or no manifestation at ground surface.

An overlying stiff crust also limits surface manifestations. At the site, the dense non-liquefiable Alluvial Terrace acts as a stiff crust over the Older Alluvium. The Alluvial Terrace crust varies in thickness from 5.5 m to 19 m (dependent on ground level). Case histories (the Christchurch earthquake sequence) indicate a non-liquefied crust in the top 5 m to 6 m reduces or suppresses the effects of liquefaction and its manifestation on the ground surface.

Further simplified assessments for liquefaction, cyclic softening and deformations discussed below were undertaken to explore the potential for foundation failures in the OBE and SEE earthquake motions.

5.9.2 Simplified Assessment - Liquefaction

Potential initiation of liquefaction is based on the ratio of the Cyclic Resistance Ratio (CRR), the soil deposit resistance, and the Cyclic Stress Ratio (CSR), which represents the seismic load. The ratio of the two is the Factor of Safety (FoS) against initiating liquefaction.

The assessment method is developed by Rollins et al (2022) and is based on a series of case histories. In this method, liquefaction resistance of sandy gravels is related to the shear wave velocity of the deposit, which is directly related to its small strain shear modulus. The shear wave velocity measurements are corrected for overburden pressure and used to derive, in combination with the earthquake magnitude (M_w), the CRR, the Probability of Liquefaction (P_L) and the CSR.

The Factor of Safety (FoS) against liquefaction initiation is the ratio of CRR to CSR:

Alluvial Terrace (sandy gravels):

- OBE Event:
  The minimum FoS is 2.26 and the calculated Probability of Liquefaction is 0 - 4%. Therefore, initiation of liquefaction is unlikely for an OBE earthquake.
- SEE Event:
  The estimated FoS is typically between 2.6 and 3.1, but in the uppermost 1 m of the profile the FoS = 1.1 and adopting the minimum V_{s1} of 322 m/s provides a Probability of Liquefaction of 15%.
  Although there is uncertainty for the SEE event because the CSR is higher than the span of the semi-empirical procedure, liquefaction is unlikely because the shear wave velocity is high, and the deposit is relatively old.

Older Alluvium (sand-like):

- OBE Event:
  The critical layer is 1 m thick at a depth of 24 m and is within the interbedded clay and gravels. The estimated FoS is 0.59 and the Probability of Liquefaction is 79%. All other layers have a FoS of 1.2 to 5.9 with corresponding Probabilities of Liquefaction of 41 % to 0 %.

Locally liquefaction may occur but the effect of the interbedded layers and location at depth are mitigating factors when assessing the possible consequences. Consequently, liquefaction triggering within the sand-like Older Alluvium is typically unlikely to occur under the OBE.

- SEE Event:
  The critical layers are at 20 m, 24-26 m and 28 m depths in the sand-like Older Alluvium. The corresponding FoS's are 0.45, 0.18-0.81 and 0.37 with Probabilities of Liquefaction of 88%, 99-63% and 92%, respectively.
  Although this assessment method suggests liquefaction can occur in these critical layers there is considerable uncertainty given the depth, age of the deposit (Early Pleistocene) and extreme ground shaking.

5.9.3 Simplified Assessment - Cyclic Softening

The clay-like layers in the Older Alluvium occur at various depths from 1.5 m to 25 m below ground level. Cyclic softening in these layers, combined with other adverse circumstances can contribute to lateral displacement and differential settlements.

The potential for cyclic softening of the critical clay-like layers is assessed using methods by Boulanger and Idriss (2007). The assessment is based on the ratio of the Cyclic Resistance Ratio (CRR) based on the deposits undrained strength properties and the Cyclic Stress Ratio (CSR), which represents the seismic and has the same value as used for the liquefaction initiation assessment above.

The CRR is based on the undrained static shear strength and initial static stress (represented by Kα). The initial undrained shear strength of 150 kPa is based on correlations with the deposit's shear wave velocity. The undrained shear strength corresponds to an estimated over consolidation ratio (OCR) of 3.26 to 4.43.

The calculated Factor of Safety (FoS) against cyclic softening in the critical layers of the Older Alluvium is:

- OBE Event:
  - Layer at 18 - 19 m depth the FoS is between 1.12 and 1.15. Therefore, cyclic softening is unlikely to occur within these layers.
  - Interbedded layers at 21 - 25 m depth the FoS is between 0.90 and 1.04, which suggests there may be potential effects of cyclic softening (MBIE, 2021).
- SEE Event:
  - Layers 18 - 19 m and 21 - 25 m; the FoS is between 0.49 and 0.63. The assessment has limitation and under extreme earthquakes significant uncertainty remains whether cyclic softening will occur and how this might be expressed.

5.9.4 Potential Settlement Deformations

Typically ground settlement depends on initial soil density, location and thickness of the critical layer, intensity of ground shaking and drainage conditions. Settlement may be caused by the loss of soil due to surface ejecta, volumetric-induced compression, and shear-induced settlement.

- Alluvial Terrace: No liquefaction is expected in the Alluvial Terrace and thus, negligible ground deformations are expected for both the OBE and SEE events.
- Older Alluvium: Seismic induced settlement from potential liquefaction or cyclic softening within the Older Alluvium are estimated for critical layers (Table 16).

Table 16 Critical Layers and Factors of Safety against deformation

Layer	Depth (m)	FoS_{OBE}*	FoS_{SEE}*
Clay-like	18	1.15	**0.63**
Clay-like	19	1.12	**0.61**
Sand-like	20	1.5	**0.45**
Sand-like	26	2.7	**0.81**
Sand-like	28	1.2	**0.37**
Interbedded	21	5.2 (**1.04**)	1.6 (**0.57**)
Interbedded	22	5.9 (**1.00**)	3.2 (**0.55**)
Interbedded	23	5.6 (**0.97**)	1.7 (**0.53**)
Interbedded	24	**0.59** (**0.93**)	**0.18** (**0.51**)
Interbedded	25	1.2 (**0.90**)	**0.35** (**0.49**)

Note: Deformations estimate where FoS ≤ 1.1
*FOS per sand-like (FOS per clay-like)

Sand-like settlement

Simplified methods using SPT or CPT data can provide estimates of ground settlement associated with liquefaction (Zhang et al. (2002). In the absence of SPT and CPT data, these parameters are estimated from correlations with shear wave velocity and then corrected for overburden pressure.

The critical layers are at significant depth and overlain by a thick non-liquefiable crust, which is expected to suppress any expression at the surface. Therefore, ejecta and shear-induced settlement are not expected.

Clay-like settlement

Cyclic softening induced settlement in clay is primarily due to the dissipation of excess porewater pressure and re-consolidation of the deposit. The cyclic softening induced settlement is estimated based on reported laboratory post-cyclic reconsolidation test results. A conservative vertical strain of 6% is the basis for the estimate for the critical clay and interbedded layers.

- OBE Event:
  Cyclic softening induced settlement of 300 mm for a 5 m thick critical (interbedded) layer.

- SEE Event:
  Cyclic softening induced settlement of ~420 mm for the 7 m thick critical (clay and interbedded) layers.

Cyclic softening deformations also depend on the soil's sensitivity and OCR. Increasing the high OCRs for a clay tends to reduce the sensitivity of the clay (residual strength), which further reduces the potential for significant earthquake induced deformations. The Older Alluvium is over consolidated and not sensitive, thus more likely to exhibit cyclic mobility (i.e., limited strain potential is more likely than flow-type deformation).

Table 17 summaries the estimated liquefaction and cyclic softening settlement associated with the critical layers.

Table 17 Estimated Settlement

Layer	Depth (m)	OBE Settlement* (mm)	SEE Settlement* (mm)
Clay-like	18		(60)
Clay-like	19		(60)
Sand-like	20		15
Sand-like	26		6
Sand-like	28		20
Interbedded	21	(60)	(60)
Interbedded	22	(60)	(60)
Interbedded	23	(60)	(60)
Interbedded	24	< 20 (60)	20 (60)
Interbedded	25	(60)	20 (60)
Subtotal		< 20 (300)	< 100 (420)
Maximum Total (sand & clay)		**300**	**< 500**

*Deformations for sand-like (deformations for clay-like)

5.9.5 Potential Lateral spreading

Lateral spreading typically occurs where critical layers occur in combination with a free face or sloping ground. The most vulnerable condition occurs where liquefied or softened layers are exposed at the free face, because the profile above the layer is not laterally constrained. However, Chu et al (MBIE, 2021) suggests critical layers at depths twice the height of the free face can contribute to lateral spreading.

The nearest free face to the site is approximately 10 m high, thus critical layers as deep as 20 m deep might contribute to lateral spreading. The free face is 35 m from the northern perimeter of the reservoir. Beyond this face the ground is relatively flat to the river channel,

approximately 170 m from the reservoir. The shallowest critical layers (Borehole BH2) are at depths of 24 m for the OBE and 18 m for the SEE.

Simplified methods provide estimates for lateral spreading (Zhang et al. (2004):

- OBE Event:
  The shallowest critical layer is 24 m bgl which is lower than the 20 m threshold and is not exposed in the riverbank, therefore lateral spreading is not anticipated.
- SEE Event:
  The seismic loads of this event are higher than those generally considered to be appliable for the empirical method. Nonetheless if this method is applied to the maximum thickness of the critical layer of 10 m then the estimated lateral displacement is less than 1 m. Consequently, the potential lateral spreading under an SEE event is unlikely to affect the stability of the reservoir embankment based on this method.

The Older Alluvium is also not exposed at free face or along the bottom of the river channel. This a favourable condition against lateral spreading displacements caused from liquefaction of the Older Alluvium and supports the small, estimated displacements.

5.9.6 Consequence Assessment

The embankment arrangement incorporates robust measures to address seismic performance requirements including:

- Foundation on stiff geologic old deposits.
- A wide embankment crest.
- Coarse granular materials within the embankment to accommodate strong ground shaking.
- Sufficient freeboard to NZDSG criteria.

In addition, there are geological factors that mitigate against the initiation or liquefaction and possible liquefaction effects, including:

- The upper crust of stiff Terrace Alluvium.
- The depth of critical layers is sufficient to mitigate against liquefaction development and effects.
- The critical layers do not daylight within the riverbank, thus mitigating against lateral spreading.

The assessed response to the two seismic events are:

- OBE Event:
  Liquefaction and cyclic softening settlement is estimated to be in the order of 300 mm. The actual settlement might be negligible, or uniform given the stiff upper crust and depth of the critical layers (greater than 20 m).
- SEE Event:
  There is greater uncertainty of the effects of the strong ground motions of an SEE event. The system response within the interbedded layers at depths greater than 18 m and the overlying stiff Terrace Alluvium crust suggests a surface expression of settlement is unlikely. The preliminary assessment estimate settlements to be less than 500 mm,

which even if it were to occur solely below the embankment would not result in reservoir overtopping.

5.10 Reservoir Margin Seismic Stability

All the slopes surrounding the reservoir are formed either by engineered embankment or as an engineered cut slope into the natural terrace to the southwest of the site. All these slope lengths are relatively small and engineered to achieve the relevant factor of safety criteria. Therefore, the seismic stability of the reservoir margin is adequate.

5.11 Reservoir Seiche

Seiche waves, solitary waves generated by earthquakes can be a consequence of either:

- A failure of a slope at the margin of the reservoir that slides into the reservoir displacing water as a solitary wave. These can occur either because of seismic activity or in static conditions, for instance following heavy rainfall. Neither of these circumstances are likely given all slopes are small and all slope surround in the reservoir are either engineered fill or engineered cut.
- Significant reservoir seiches can occur if the natural frequency of the reservoir is at or close to resonance with the dominant frequency of the earthquake waves affecting the site. In most cases normal freeboard provisions should be sufficient to safely accommodate seiches generated by strong ground motions.

The possibility of resonance seiche may be of greater significance if the reservoir is close to a fault. NZDSG suggests the possibility of seiche should be considered where a Medium PIC dam is close to a fault as is the case for the Poads Road reservoir.

The assessment of seiche by resonance is based on the methods by Sato (1967), which covers 2 dimensional and 3 dimensional theories. The dominant earthquake period is assumed to be 0.2 seconds and the near-by fault is assumed to be purely strike slip. Given these parameters:

- Seiche wave height estimate is approximately 330 mm.
- The reservoir resonance period – 2 D Theory is 1.6 minutes.
- The reservoir resonance period – 3 D Theory is 0.8 minutes.

Therefore, overtopping of the embankment by an earthquake generated seiche is unlikely as seiche wave height is significantly less than the available freeboard.

6.0 Flood Hydrology

6.1 Introduction

The reservoir is not on a river course. Therefore, the hydrology of the regional catchments (Ōhau, Makahika and Makaretu catchments) do not govern or provide constraints on arrangements for the reservoir embankments or its spillway. Nonetheless, the following hydrological considerations influence the design and arrangement of the scheme:

- **Rainfall at the site**: The rainfall profiles for events of different return periods affect the volume of water falling directly on the reservoir surface, which governs the spillway arrangements.
- **Ōhau River:** The intake is to be constructed in the riverbed. Therefore, the hydrology of the river at the intake location affects, the general arrangement of the intake, considerations of scour and intake stability, its construction, and the flows available for abstraction.
- **Makahika River:** The Makahika River confluence with the Ōhau River is downstream of the site, but upstream of the Poads Road bridge over the river. The hydrology in the combined rivers affect the design clearance for the pipe bridge over the river and the flows contribute to the flow gauges at Rongomatane, which has the longest and most consistent river flow records on the river system.
- **Makaretu Stream:** The Makaretu Stream joins the Ōhau River downstream of the Poads Road bridge but upstream of Rongomatane. Therefore, the flows in this river system also contribute to the flows gauged at Rongomatane.

6.2 Catchments and Rainfall

The Ōhau catchment is to the south-east of Levin and at the river mouth commands an area of about 180km^2. However, downstream of Rongomatane the watershed boundary is diffused and difficult to define across the coastal plain.

The three greywacke hill country catchments converge in the reaches above Rongomatane: the Makahika, upper Ōhau and Makaretu catchments (Figure 13). These are typically vegetated with native forest and have a combined area of about 104 km^2.

The Ōhau watershed extends to an elevation of about 1100 m RL in the Tararua Ranges and has a mean annual rainfall of 1825 mm (1961-90). The catchment has a large rainfall gradient that varies from 800mm at the coast to about 2600mm at the top of the catchment. Above the Rongomatane flow gauge the mean annual rainfall is 2260 mm. The mean naturalised flow at Rongomatane is 6.58 m^3/s (1974-2022).

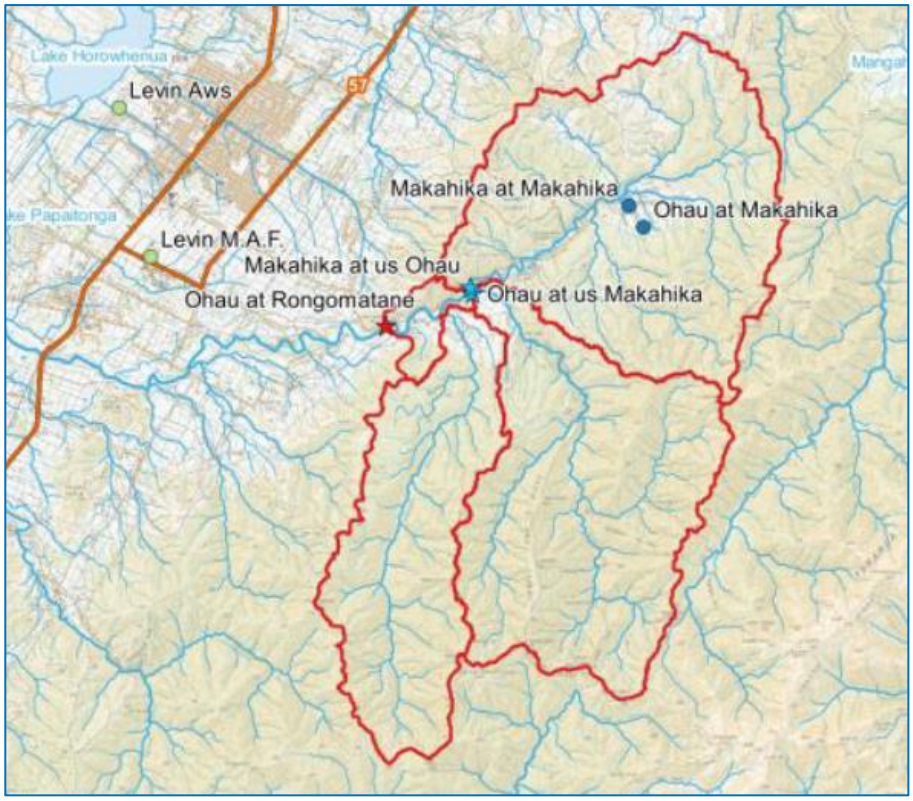


Figure 13: Catchments Upstream of Rongomatane

6.3 River Flow Distribution

Flow records on the Ōhau River are available from January 1974 onwards from two sites upstream of the current Levin Water Treatment Plant intake (Table 18). The current flow gauge site at Rongomatane was established by NIWA in 1978 and is now operated by Horizons Regional Council (HRC). This is used to regulate surface water takes on the Ōhau River.

The historical Ōhau River flow record is influenced by abstraction related to the Levin Water Supply at various times and at two locations. Prior to 1 July 1995 flow diverted at the old Horowhenua District Council water supply intake upstream of Poads Road bypassed the river flow gauges. In addition, from 1978 until March 2002 flow diverted into the Ōhau Water Race immediately downstream of the earlier Ōhau at Water Race flow gauge, bypassed the current site at Rongomatane.

A naturalised flow dataset in which the diverted flows are added to the recorded river flows was assembled for the Ōhau River Flow Allocation Project. This record is extended for the present study by appending flow recorded at Rongomatane since 16 April 2003 and which is the natural flow of the river.

Concurrent flow gauging has been carried out by NIWA and HRC at Rongomatane and various other locations on the river including on the Makahika Stream and Ōhau River at their confluence.

Table 18: Available Hydrological Data

Site name	Area (km^2)	Map reference NZMG	Records
Ōhau R. at Rongomatane	105	2707180 6057750	Digital record from 14/7/1978 to present
Ōhau R. at Rongomatane (naturalised flow)	105	2707180 6057750	Flow record (18/1/74 to 16/4/2003) adding in diverted flow at old Poads Rd intake and Ōhau Water Race
Ōhau R. u/s Makahika Confluence.	36.5	2709600 6058600	22 flow gaugings, 18 concurrent with Rongomatane.
Makahika Str. u/s Ōhau Confluence.	40.6	2708800 6058500	51 flow gaugings, 30 concurrent with Rongomatane.

6.4 Extreme Events

Concurrent flow gaugings after March 2002, which measured the natural river flow, are used to derive linear regression correlations for flow in the Ōhau River and Makahika Stream upstream of their confluence. The relationships suggest flows in the Makahika Stream are approximately double that in the Ōhau River, despite the catchments being of a similar size. Alternatively, the flow in the Ōhau River at the reservoir site is approximately 35% of the combined flow at the Poads Road bridge, downstream of the Makahika Stream and the Ōhau River confluence.

The Horizons Regional Council indicative flood extent map (2021) suggests in high flows the Ōhau river is constrained at the Poads Road bridge reach which cause backwater effects in the river reaches upstream of the confluence of the Ōhau River and Makahika Stream. The flood extent at the reservoir site is approximated by the 118 m RL contour, which is roughly the crest of the lower terrace below the reservoir site.

John Philpott and Associates Ltd (2020) provide an assessment of flood flows at the Poads Road bridge, which can be compared with estimates for river flows at the reservoir site (Table 19). Since the reservoir site is not on the Ōhau River, it is an off-river location above the left bank, accurate estimates of flood flows are not required for the reservoir design.

Table 19: Flood Flow Estimates in the Ōhau River

Annual Return Interval (ARI)	Annual Exceedance Probability (AEP)	Flow Estimate at Poads Road Bridge*	Ōhau River at Reservoir Site	
			35 % of Poads Road Bridge	Rational Method
200 years	0.5 %	535	187	212
100 years	1 %	467	163	180
50 years	2 %	405	141	148
20 years	5 %	330	115	117
10 years	10 %	Not given	Not applicable	93

*John Philpott and Associates Ltd (2020)

7.0 Potential Failure Modes

7.1 General

A potential failure mode (PFM) is a series of events that could lead to dam failure and an uncontrolled release of the impounded reservoir water. As outlined in the NZDSG identification and avoidance of a potential dam failure mode, or mitigation to prevent or reduce the probability of a potential dam failure mode developing, is a cornerstone of effective dam design.

Potential failure modes are typically identified under a range of operating and loading conditions (e.g., normal operational conditions, floods, earthquakes, etc). These loading states represent the conditions that must be present for a PFM to be considered likely to occur.

An outline potential failure mode analysis was conducted early in the preliminary design, initially to inform the PIC classification process. The PFM analysis process includes a discussion of the likely conditions and potential modes of failure that could occur. Table 20 includes a list of PFMs that were considered for normal and extreme loading conditions.

The probability of failure of a properly engineered, constructed, and maintained dam, such as the proposed for the Poads Road Water Supply Reservoir, is extremely low. The analysis of PFMs does not reflect adversely on the condition or integrity of the proposed reservoir.

Table 20: Reservoir Potential Failure Modes

PFM No.	Potential Failure Mode Description			
	Initiating Hazard	**Potential Failure Mechanism**	**Impact on the Structure**	**Credible?**
1	Normal operation	Geomembrane liner failure (on either the embankment, reservoir base, or at the interface with a concrete structure) due to unidentified construction defect, wind damage or long-term degradation.	Concentrated seepage through embankment, foundation or at conduit interface leads to internal erosion of embankment which progresses undetected resulting in internal erosion* failure of embankment	**Yes**
2	Normal operation	Mis-operation of inlet structure causes water level to rise above Full Supply Level and overtop embankments.	The spillway provides controlled release of water above full supply level and prevents embankment overtopping.	No
3	Flood	Flood entering from Ōhau River.	Reservoir is off-river storage, and not in the floodplain.	No
4	Heavy Rainfall	Run-off from nearby southwestern catchment enters and surcharges the reservoir.	There are interception surface water drainage ditches to prevent overland surface water run-off entering the reservoir.	No
5	Heavy Rainfall	Extreme rainfall falling directly on pond surface area causes water level to rise above Full Supply Level with continuing water supply from intake.	Extreme precipitation can be absorbed by pond freeboard and spillway provide controlled release of water above full supply level.	No

PFM No.	Potential Failure Mode Description			
	Initiating Hazard	Potential Failure Mechanism	Impact on the Structure	Credible?
6	Seismic	Extreme seismic ground shaking causes deformation (e.g., dynamic settlement, cracking) of embankment and failure of geomembrane liner.	Concentrated seepage through embankment leads to internal erosion of embankment which advances undetected resulting in internal erosion* failure of embankment.	**Yes**
7	Seismic	Extreme seismic ground shaking causes cracking of embankment and liner at interface with concrete structure	Concentrated seepage through embankment leads to internal erosion of embankment which advances undetected resulting in internal erosion* failure of embankment	**Yes**

Notes: * Internal erosion failure of an earthen embankment dam refers to the situation where unchecked internal erosion leads to the development of an uncontrolled flow path through the embankment, large enough to result in unravelling or instability of the embankment material leading the breach.

7.2 Credible Potential Failure Modes

Three potential failure modes (PFM No. 1, 6 and 7) are considered credible and could result in an uncontrolled release of the storage pond water. Although the design arrangements include several features that provide overlapping measures for resilience the theoretically Credible PFMs are discussed below.

7.3 PFM No. 1: Normal Conditions – Geomembrane Liner System Failure

The first credible PFM are the consequences of a liner system failure under normal operating conditions leading to excessive leakage through the embankment. The locations for a liner failure that might generate the most significant consequences are:

- Failure near the upstream toe of the embankment where water pressures are highest.
- Failure at liner interfaces with the concrete draw off and low level outlet structure.
- Failure caused by an unidentified construction defect, wind damage, vandalism, or long-term degradation.

Liner system failures can introduce high pore pressures into the embankment fill and could increase the likelihood of internal erosion through the embankment.

To mitigate against internal erosion there is a central chimney drain along the full length of the embankment. This chimney drain is protected against internal erosion by filter layers on both sides of the drain. In addition, the toe drains and filters at the foundation contact below the downstream shoulder protect against internal erosion through the foundations.

The integrity of the liner system is important to reduce water loss to the underlying gravels. Therefore, construction quality control and routine monitoring, surveillance and maintenance of the geomembrane is necessary to minimise the risk of liner failure.

The additional design measures in place provide a resilient facility even if there is a local failure of the liner system.

7.4 PFM No. 6 & 7: Seismic – Geomembrane Liner System Failure

PFMs 6 & 7 are the consequence of a potential liner system failure as a consequence of an earthquake. The potential consequences are similar to those for PFM No. 1, but the stresses and strains induced by the earthquake motions cause the liner failure.

The locations that are most vulnerable in an earthquake are where:

- The embankment changes direction and particularly where the embankment is highest (PFM No. 6).
- Rigid concrete structures abut the more flexible embankment, i.e., the low level outlet structure (PFM No. 8).

Excessive stresses and strains at these locations could rupture the liner systems. The integrity of the liner system is important in minimising the risk of these mechanisms. Therefore, seismic resistant design features are employed to minimize the risk of failure as part of detailed design.

However, should ruptures of the liner system occur the chimney drain, and toe drain arrangements prevent embankment failure. Seepage collection and measurement from these facilities allow liner ruptures to be identified.

Special inspections and dam safety reviews after earthquakes will be included in the monitoring, surveillance, and maintenance procedures.

8.0 River Intake

8.1 Introduction

The river intake must be able to extract water from the Ōhau River when it is in various flow conditions and convey the water to the water storage reservoir. The extraction rate is variable, and dependent on the river flow. It is also desirable to extract water from a location and in flow circumstances where there is little, or no sediment suspended in the extracted flow. Once the river flow reaches higher flood flows, the suspended sediment concentration tends to increase.

In addition to the functional requirements of the intake, considerations influencing the choice of intake site and intake arrangement are:

- **Fish Passage:** The intake should not impede fish passage during either construction or operation.
    - Intake structures which do not change the riverbed geomorphology, in the permanent condition, are preferable to structures which do present some form of barrier.
    - If some form of barrier is presented, then it must be designed to provide for fish passage past the barrier. Design should be in accordance with the New Zealand Fish Passage Guidelines which have been incorporated by reference into the National Policy Statement for Freshwater Management (NPSFM) (i.e., the guidelines have the same legal effect as the NPSFM).
    - Fish passage will need to be designed for indigenous species as well as trout (the Ōhau River is valued for Trout Fishery under the One Plan, Horizons Regional Council).

- **Disturbance During Construction, Operation and Maintenance:** Any disturbance to the riverbed and riparian vegetation should be minimised and the effects of any disturbance are required to be avoided, remedied, or mitigated.

- **Cultural Effects:** Cultural effects cannot be determined without engagement with the relevant iwi and hapū. This notwithstanding, experience from recent Waka Kotahi projects has yielded the general principle in this region that structures within the riverbed have an adverse effect on the mauri of the awa.

8.2 Location options

Three locations provide a possible extraction point for water from the Ōhau river (Figure 14). These range from locations upstream of the proposed reservoir to a location near the existing water treatment plant. The locations upstream are likely to have less sediment load, but the locations downstream have greater base flows. Three locations provide a means of exploring the factors involved and form the basis for an multi criteria assessment (MCA).

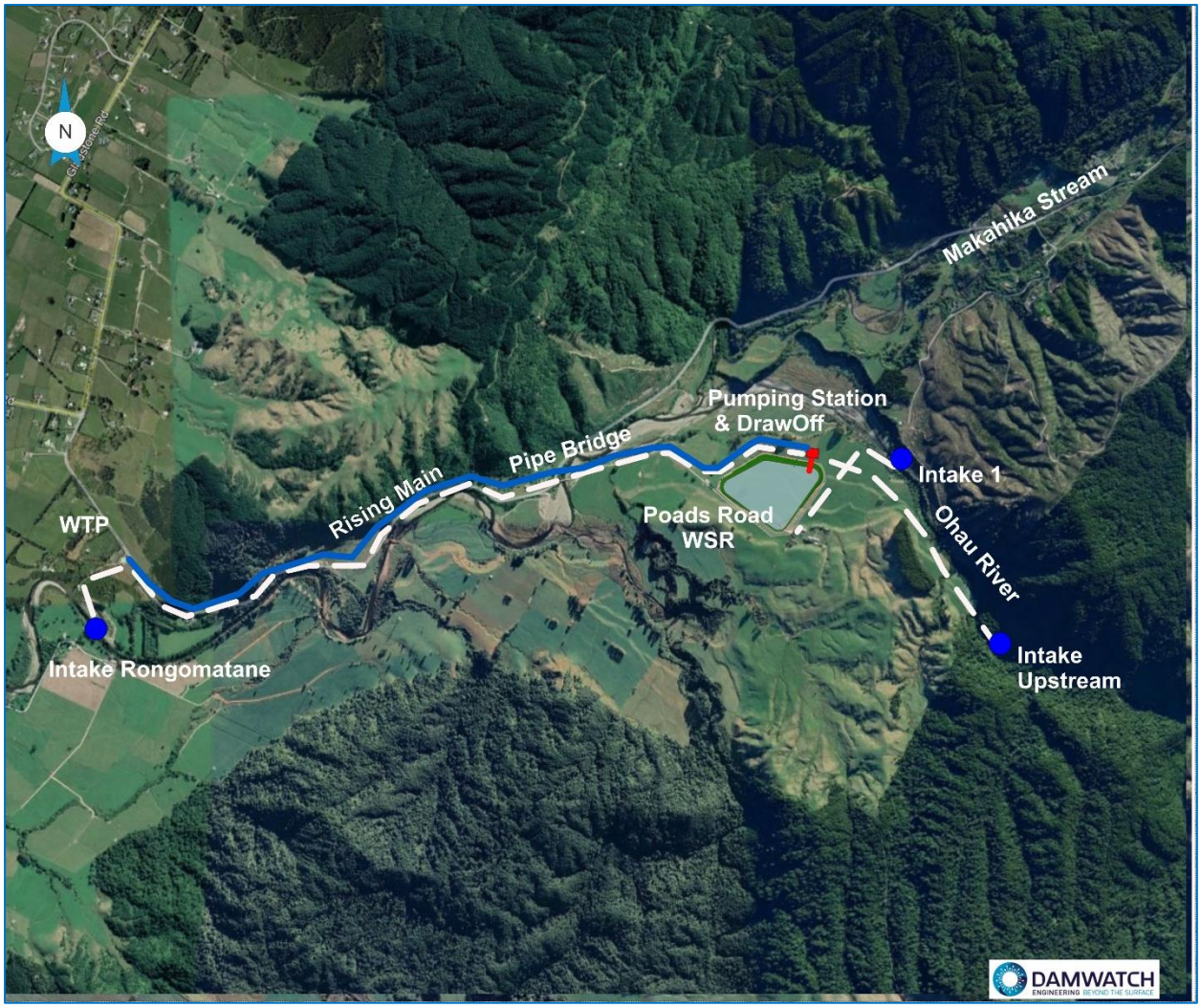


Figure 14: Intake Location Options

8.2.1 Intake A – Upstream near the Historical Intake Location

Approximately 1.2 km upstream of the reservoir on the Ōhau River is the location of the historical intake for town water supply. This location permitted water to be abstracted from the river and then conveyed in a pipe to the 118 m RL river terrace at the reservoir's location. the confined riverbed cross section provides a stable river regime for abstracting water and maintaining a reliable location for flow monitoring.

The intake option could extract flow across a wide flow range by a combination of a gravity intake and booster pumps. The intake would consist of:

- Coanda, curved intake screen near the left bank; an arrangement that has been used elsewhere in New Zealand for water supply intakes. This would be set into a 1.2 m low weir and might extend about 5 m across the riverbed.
- A rock ramp fish passage on the right side of the riverbed.
- Water level monitoring for river flow.
- Intake chamber on the left bank of the river with a flow isolation gate, and by wash scour gate.

- A radio or satellite communication system to transmit the level and flow data to the scheme's control room.
- Twin HDPE pipes (450 mm diameter) to convey the water to the pumping station at the toe of the reservoir embankment. The upstream end of the pipeline would require clearance of bush and excavation of an access platform.
- Booster pumps in a pumping station to raise the water to the top water level in the reservoir.
- The location of the intake and the pipeline is not within DOC land but is within land not owned by HDC.

The flow that could be extracted from the river is limited by the size of the pipes conveying water from the intake to the reservoir.

8.2.2 Intake B - Near the Reservoir

The Ōhau riverbed close to, and about 50 m upstream of the reservoir is approximately 80 m wide and the terrace at this location is above the nominal flood level in the river. This river reach is a possible location for an infiltration gallery buried in the riverbed. The water would be pumped from the riverbank collection sumps to the reservoir. The intake flow is limited to specific extraction rates, determined by the number and capacity of pumps. The intake would consist of:

- An infiltration gallery of perforated pipes buried in the riverbed to collect water flowing through the riverbed. Construction in the riverbed would extend across a part of the riverbed and approximately 45 m along the riverbed.
- A back flushing system buried in the riverbed with the infiltration gallery pipes to allow periodic flushing to clear the surrounding gravels of trapped sediment.
- Two sedimentation sumps in the left riverbank.
- Two pump sumps. In each sump would be two submersible pumps discharging to an individual rising main. The adoption of two sumps allows each sump to be circular and minimises the structural requirements for a four-pump arrangement.
- Four HDPE rising mains conveying water to the reservoir's top water level. The adoption of four rising mains reduces the power requirements and increases the system's operational flexibility and long-term resilience.

The extraction rate for this option is dependent on the infiltration gallery size, the number and size of pumps and number of pipes conveying water to the reservoir. The ability to abstract water is further restricted by the fixed duty of the pumps. Given the arrangement for this option the abstraction rate would be approximately 400 l/s.

8.2.3 Intake C – Downstream at Rongomatane

Like Option B, the intake option at Rongomatane also includes an infiltration gallery, pumps station and rising mains to the reservoir. However, the location of the intake requires significantly different approaches to the arrangements of the components:

- The riverbed width at Rongomatane is constrained between banks and is about 35 m across in this river reach. Thus, construction of an infiltration gallery would extend across the full width of the river and extend possibly 100 m downstream. Construction

would require a temporary diversion of the river outside its riverbanks, probably across the opposite river terraces.

- A back flushing system buried in the riverbed with the infiltration gallery pipes to allow periodic flushing to clear the surrounding gravels of trapped sediment. Given the increased concentration of sediment in the river downstream of the Makahika River confluence, backwashing is likely to be more frequent than for an infiltration gallery at location B1.
- Two sediment trap sumps to reduce the sediment load that would damage otherwise damage pumps and pipelines.
- A single pumping station with 8 pumps constructed in the right bank of the river, downstream of the current intake location. The location is intended to minimise the potential interference with the current intake during construction.
- Four HDPE rising mains to convey the abstracted flow ~3.2 km along the Gladstone and Poads roads to the water storage reservoir. Given the route is to be shared with the road and other utilities the number of feasible pipes is probably limited to four. Two of these pipes would provide the dual purpose of conveying water from the reservoir to the water treatment works at Rongomatane. This arrangement requires a series of interlinked values to permit pumping in both directions with adequate protection embedded in the control system to prevent the pumping systems at each end pumping against each other.

The extraction rate for this option is limited by the hydraulic head loss the long rising main.

Dependent on the infiltration gallery size, the number and size of pumps and number of pipes conveying water to the reservoir, the ability to abstract water is further restricted by the fixed duty of the pumps. This intake option arrangement has the highest capital cost, highest operating cost and delivers the lowest flow rate of ~350 l/s.

8.2.4 Multi-criteria Assessment

Multi-criteria assessments (MCA) explore the merits of options against a set of objectives, for which established measurable criteria are set by a project team. An MCA uses objectives, criteria, measures, weightings and scoring approaches to rank and compare options. When applied consistently, an MCA is a suitable approach for filtering options and to inform decisions.

Each Intake Option is scored against common criteria and given a rank between 0 (worst) to 4 (best) for each criterion in comparison to the other options. Each criterion is given a common weighting which is proportionate to its importance for the overall outcome (1 – worst to 5 – best); this is multiplied against the criteria rank score for each option to achieve a weighted score. Weighted scores for each criterion are then summed for each option to get a final score; used to rank the options. The criteria are set out in

Table 21.

Table 21 MCA Criteria Summary

Criteria	Explanation	Weighting
CAPEX – Construction	Cost brackets for undertaking the option, including design & construction	5
OPEX – Annual Power	Power cost relative to the other options.	3
Operational Complexity	Complexities with operational system – pumping, SCADA, valves required	2
Design Requirements	Based on perceived complexity of the proposed option and amount of design considerations.	1
Constructability	A reflection of construction complexity.	1
Water Quality – Composition and NTU	Expected Water quality at each location.	3
Available Volume for Requirements	Sufficient Water to Achieve Performance Requirements	5
Pumped Volume	Volume able to be pumped	5
Consenting Ease	Measured as effort to consent. No option deemed insurmountable to consent.	3
Serviceability	Ease at which maintenance and future works can be undertaken on the intake.	1
Land Ownership	Ease of land access through ownership.	3
Access ease	Ease of access due to terrain	3
Additional Benefits	Secondary benefits over and above the primary objective	1
Environmental Risk	Relative environmental risk score for the proposed option based on introduction of environmental hazards during construction	5
Intake Life allows design life of Reservoir	Does the intake expected life match the design life of the reservoir	1

The MCA assessment yields logical results from the consideration of intake location and type of intake against the criteria. A sensitivity assessment on the weightings in several combinations yields the same outcomes, which indicates the outcomes are robust within the parametric limits of the process. The outcome of the MCA process is presented in Table 22.

Table 22 MCA Option Weighted Rankings

Rank	Option	MCA Score
1	B - Infiltration gallery within the Ōhau River ~500m from the WSR.	119
2	A – Gravity intake located close to the historic intake ~1km upstream of the WSR on the Ōhau River	103
3	C - Infiltration gallery within the Ōhau River at Rongomatane ~3.25km downstream of the WSR, with a pumping main back up to the WSR.	58

Thus, the intake option at location B near the water supply reservoir which includes an infiltration gallery is adopted for the feasibility design.

8.3 Infiltration Gallery at Location B

The infiltration gallery arrangement consists of perforated pipes buried into the gravel riverbed. The water gathered from several collection pipes flows by gravity to a sump buried in the riverbank. From here the flow is pumped to the reservoir. The gallery abstracts water efficiently from the gravels within the riverbed. Therefore, the hydraulic behaviour of the riverbed dominates the system's design.

Infiltration galleries are used extensively across New Zealand and other parts of the world. Experience in New Zealand (Aqualinc, 2014a) (Cawthorn Institute, 2016) and elsewhere note that over time sediment tends to clog the pack around the collection pipes, reducing the yield. Periodic clearing of the sediment clogging is often required. This can be undertaken either by:

- Scarifying the riverbed with equipment such as a tractor and hoe. However, this activity tends to introduce significant and undesirable sediment loads into a river when it is at a low flow.
- Incorporating a series of additional and smaller pipes within the gallery to force a mixture of air and water through the pack to dislodge and clear the granular materials to restore the yield. Backwashing need not be done at low flow conditions in the river, the effect on the riverbed is minimised and the effect on the potential sediment load is much reduced.

Preserving the water quality of the river in low flows is desirable, therefore the feasibility design for the infiltration gallery incorporates backflushing facilities to restore the gallery yield in stages across two units.

The proposed intake location is downstream of the riverbed rock and gravel bed interface. Therefore, in the absence of site investigations for the feasibility design, the depth of gravel in the riverbed may be shallow at the intake location, which can make an infiltration gallery susceptible to washout, undermining and scour. Therefore, the arrangements at this design stage for the intake are intended to be robust to guard against washout.

Although the Ōhau River widens downstream within 100 m of Location B, which would alleviate intake construction effects, the alluvial terrace adjacent to this point is lower than the indicative flood level (118 m RL). Therefore, any associated structures such as sumps and backwash air pumps constructed on the terrace would be at risk during flooding.

This river reach has the beneficial characteristics of relatively high river flow velocities and meandering river bedforms. In these circumstances fine particles are entrained in the flow by turbulence and transported along the river in suspension (Aqualinc, 2014a). This reduces 'armouring' of the riverbed in and around the vicinity of the gallery and assists in maintaining the desired yield.

The feasibility design for the infiltration gallery is based on the guidance by the Agricultural and Agri Food Canada (2006) for infiltration galleries and backflushing facilities. At the detailed design stage various aspects of the arrangement will be revisited, following investigations to support the design development. These investigations include:

- River hydrology.
- River morphology.
- Assessment of material grading in the riverbed.

- Assessment of permeability of the riverbed.

The arrangement includes (Figure 15):

- 2 infiltration units, each with collection pipes and backflushing pipes.
- A single sedimentation sump and pump sump for each infiltration cell. Thus, there are two pump sumps.
- 2 submersible pumps in each of the two pump sumps.
- 4 rising main pipes to convey the water from each of the four pumps to the reservoir crest.

Although the proposed arrangements include features to provide a robust intake for the scheme, infiltration galleries are embedded within a riverbed form that moves and changes with each flood flow. Therefore, as experience across New Zealand and elsewhere attests, adopting an infiltration gallery as the intake arrangement:

- Requires maintenance.
- Recognises possible changes to the intake efficiency as the riverbed from changes.
- Incurs risks of washout of the gallery in high flood flows.

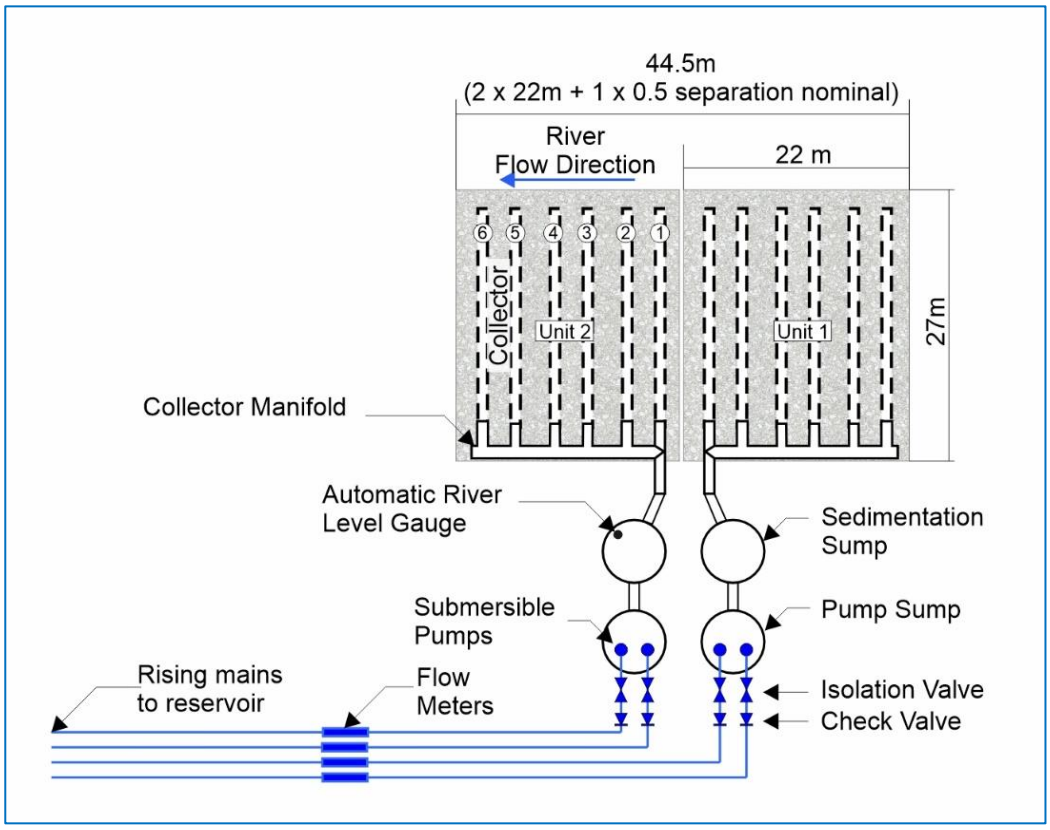


Figure 15: Infiltration Gallery Schematic Arrangement

8.3.1 Infiltration cells

Infiltration galleries are buried in the riverbed below the depth at which scour, or fluidisation of the riverbed is likely to occur in high river flows. In many circumstances this depth is 1.5m below the nominal riverbed.

However, scour processes are random and subject to local turbulent energy changes. Therefore, assessments of scour depth are empirical and yield a variation of estimates. Four different empirical methods for estimating the potential scour depth suggest that a burial depth of 1.5m at the intake location might be within the zone where scour or bed fluidisation might occur at high river flow. For this reason, the infiltration cells are encapsulated within gabion mattresses, an arrangement which has the following advantages:

- Each infiltration cell within a gabion mattress is a single structural unit which is more likely to resist the effects of high energy river flows.
- The collection pipes and backflushing pipes have greater degree of protection from being swept out in high river flows.
- The gabions can be filled with relatively open gravel and cobbles to maximise the possible yield from the infiltration cells.
- If the gallery was not encapsulated, the depth of burial in the riverbed would probably be deeper, requiring greater depths of excavation on the riverbed, and longer construction times. Thus, the use of gabions potentially reduces the construction effects in the river.

The arrangement includes two discrete cells so they can be back washed individually and at different time. Thereby, the intake can abstract water whilst regenerating the yield in the other cell by backwashing.

8.3.2 Collection pipes and surrounding filter pack

The graduation of the granular materials around the collection pipes and the backflushing pipes are determined by the perforation size in the pipes, which can be assessed in detailed design. Likewise, the filter compatibility between the gabion materials and the riverbed materials can be assessed in detailed design once appropriate investigations of the river bed have been undertaken.

Nonetheless, a gallery system is subjected to dynamic loading from the oscillating pressures in the flow and seasonal flow fluctuations. Therefore, the pipes must resist the forces and be durable to extend the longevity of the intake:

- Steel pipes strong but tend to corrode.
- PVC Plastic pipes must be well aligned, fully supported, and possess sufficient strength to resist various loads.
- HDPE pipes are strong, inert and conform to movement changes.

For these reasons single smooth wall HDPE pipes are proposed for the construction of the infiltration collection pipework.

8.3.3 Backwash pipe system

Backwashing with water alone is a relatively ineffective method for restoring the gallery yield and requires a significant water flow. Therefore, the flow rate available for backwashing is limited by the capacity of the gallery itself, which, diminishes between backwash cycles. For this reason, backwashing should employ a mixture of water and air.

The air-scour-assisted backwash method, where air and water are introduced simultaneously, is possibly the most effective and efficient, because the necessary water flow is less than that required for full bed fluidisation.

The design approach is based on the methods used for the design of backwashing filter beds in water treatment works for urban water supply. The validity of the design approach, including the design for the air and water diffusers, has been verified through testing on a physical model (Agricultural and Agri Food Canada, 2006). The arrangements for backwashing will be developed in the detailed design.

8.4 Sedimentation Sumps and Pump Sumps

The water in the collection pipes is collected in a manifold in each gallery cell. This is then directed to the riverbank where the sedimentation and pump sumps are set into the riverbank.

The sedimentation sump reduces the sediment load in the water to reduce the progressive wear on the submersible pumps and ensures the flow in the collection pipes flow full.

The arrangement of the pump sumps and the overflow from the sedimentation sumps to the pump sumps are such that:

- The level is the same as the nominal low flow level in the river.
- The volume in the pump sump below the connection between the two chambers is sufficient to allow for the cut-in and cut-out of there is sufficient volume to prevent the pumps burning out with pumps starts being too frequent.
- The base of the sumps is set at a level to provide minimum requirements for submergence when the pumps cut out.
- The structural thickness of the sump walls and base are sufficient, with a margin of safety, to prevent uplift if the water level in the river reaches the flood level, which if the cover level of the sumps.
- There is to be at least one meter water depth in a sedimentation sump. This will continuously record the river level, which will be calibrate with the flow rate in the river.

8.5 Rising Main to Reservoir

Each of the four pumps, installed in the two pump sumps, is associated with its own rising main discharging to the reservoir. The arrangement of pumps and rising mains allows for:

- The ability to switch pumps on and off to extract water from the river at different rates as a proportion of the river flow, as the river flow rate rises and falls.
- The minimum extraction rate is 100 l/s using one pump and the maximum uses for four pumps to extract roughly 400 l/s.
- The discharge pipework for each pump has an isolation valve to allow for extraction of the pump for maintenance.
- The discharge pipework for each pump has a non-return valve to protect it at pump shut down.
- The discharge pipework for each pump has a flowmeter to record the instantaneous flow rate from each pump along with the time. When these records are coupled with the river

flow gauging from sedimentation sump, compliance with consent conditions can be established.

The four rising mains to the reservoir are buried in a trench with the following characteristics:

- The trench alignment is to follow the boundary of the property and reservoir works, i.e., to the southeast of the spillway alignment.
- The four rising mains are HDPE smooth wall pipes, where the sections are butt fusion welded.
- The cover depth to the rising mains is 600 mm, greater depths are not envisaged because the route does not cross a vehicle access way.
- The nominal discharge of the rising mains is over the crest of the reservoir embankment to ensure that there is a free discharge from each of the mains, which prevents back siphoning from the reservoir to the intake.

9.0 Embankment and Liner System

9.1 Introduction

The reservoir embankment is categorised as a Medium PIC dam and the design is consistent with the performance requirements for this PIC category set out in NZDSG. The embankment design considers the following potential failure modes as a basis of meeting the performance requirements:

- Earthquake induced deformations result in crest settlement leading to overtopping and failure.
- External factors or earthquake induced deformations result in damage to the geomembrane liner, allowing leakage into the embankment leading to instability or toe unravelling.
- External factors or earthquake induced deformations result in damage to the geomembrane liner, allowing leakage into the embankment leading to internal erosion and piping failure.
- Earthquake induced deformations result in damage to the geomembrane liner and embankment cracking, leakage along through going transverse cracks lead to downcutting and failure.

The integrity of the upstream geomembrane lining plays an important role in the embankment's performance. Damage of the geomembrane lining may occur due to external factors or earthquake loading and would allow leakage into the embankment. To address this possibility the embankment design includes additional zoning for a filter and drain as defensive design measures.

The embankment design and zoning are provided for the following purposes:

1. A wide crest and relatively shallow side slopes for inherent stability.
2. A filter for protection against internal erosion within the embankment and along the foundation.

3. A vertical chimney drain, and toe drain blanket below the downstream shoulder to
    a. maintain unsaturated conditions within the downstream shoulder and thereby enhance stability.
    b. protect against toe unravelling.
4. A vertical chimney drain extending to the crest to act as ‘crack stopper' for protection against through going cracks, leakage and downcutting.

9.2 Embankment Design

The embankment includes broad upstream and downstream shoulders of bulk fill, a central filter and chimney drain. The filter and drain are downstream of the embankment’s centre line and connects at formation level to the horizontal filter and drainage blanket, which extend to the downstream toe. The crest width is six meters, providing suitable access to the crest.

The upstream slope is overlain by a geomembrane liner system. The surface of the geomembrane liner is protected by riprap across the base of the reservoir and near the embankment crest (Figure 16).

Foundation to the embankment include Alluvial Terrace deposits and these are underlain by Older Alluvium.

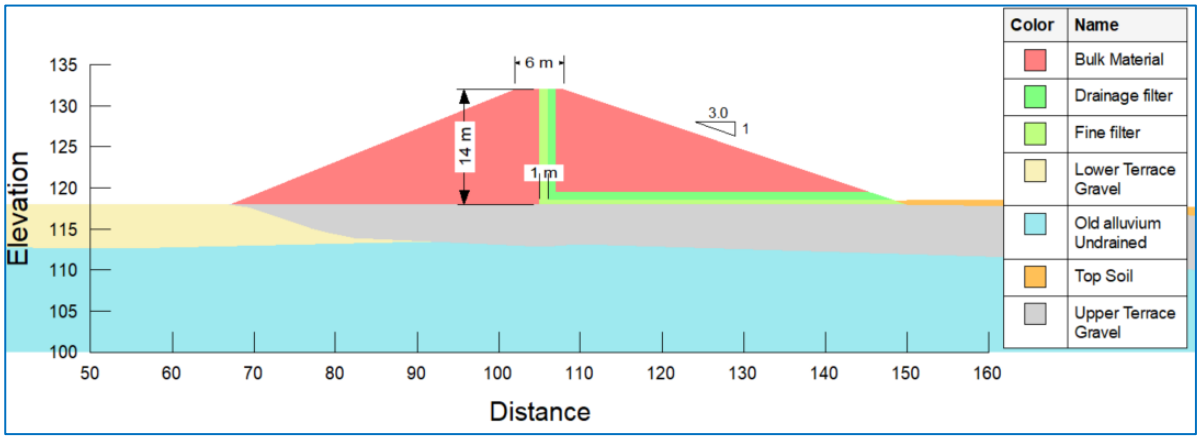


Figure 16: Embankment Typical Cross-section and Zoning

The embankment slopes support the upstream geomembrane and meets seismic stability criteria:

- The internal slope is at 2.5H:1.0V.
- The external slope transitions from 2.5H:1.0V at minimum fill height of 5 m in the southern area of the pond to 3.0H:1.0V at the maximum fill height of 14 m in the northern area of the pond. The transitioning of external slope reduces the embankment footprint whilst meeting seismic stability performance of the downstream shoulder.

The thickness of the filter and drain meet requirements for constructability, to remain functional post-earthquake, and control leakage should the geomembrane be compromised geomembrane. A refinement of the filter and drainage blanket dimensions may be appropriate during detailed design stage. For the feasibility design:

- The vertical filter and drain are 1.0 m wide.

- The horizontal filter is 0.5 m thick and provides material compatibility between the foundation Alluvial Terrace soils and drainage blanket.
- The drainage blanket is 1.0 m thick.

At the downstream toe a leakage collection system will convey potential leakage away from the embankment. The Alluvial Terrace soils are dense to very dense and provide a suitable foundation for the embankment and downstream toe.

9.3 Embankment Bulk Fill

The design assumes that the embankment bulk fill will be sourced from excavation within the Alluvium Terrace and Older Alluvium. The design is managed to achieve this wherever possible. For this purpose, the grading envelope for the bulk fill was developed.

Figure 17 shows the design grading envelop for the bulk fill (black solid and dashed lines). Selected gradings from the investigation samples with oversized particles included are also shown. The maximum fines content (<0.075 mm) of the bulk fill is set at 25% to accommodate majority of site soils. Investigation sample gradings listed in Table 11 with higher fines content are not shown in the figure. Should site soils have significantly lower fines content then the need for drainage zones may be reconsidered in detailed design.

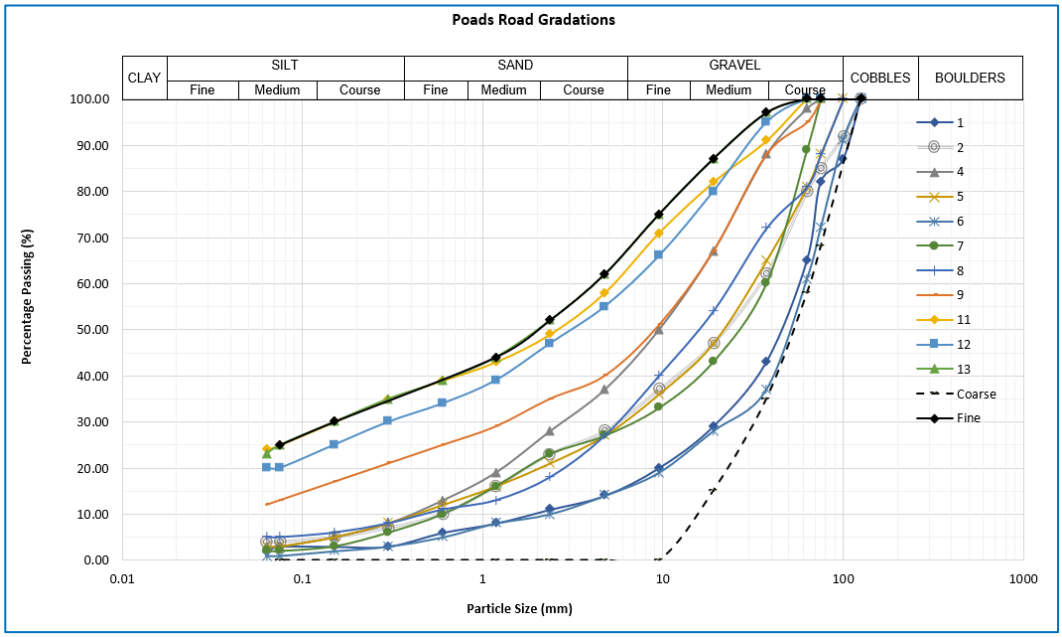


Figure 17: Embankment Bulk Fill Grading Envelope

9.4 Filter Zone

The upstream shoulder side of the chimney drain and the toe drain require a filter transition from the general fill to the drainage material (Figure 16). The filter design follows the procedures provided by Fell (Fell M. S., 2015) and additional guidance provided by the Filter Design Manual (FEMA, 2011) to define the filter bandwidth. The design is based on the material grading of the embankment's bulk fill as the "base soil" and then the filter zone because the "base soil" for the

drainage zone. Table 23 provides the filter grading envelop. Figure 18 shows the filter grading envelop.

Table 23 Filter Design Grading Envelop

Filter Grading Envelop		
Particle Size	**Percentage Passing (%)**	
(mm)	Fine	Coarse
20.00	100	100
12.00	100	90
4.75	100	
3.40		60
1.30	60	
0.70		15
0.58		10
0.30	15	0
0.25	10	
0.075	2	

The thickness of the filter zone must consider both the minimum necessary to achieve the technical requirements and the practicalities of construction. The construction constrains generally determine the minimum thickness of a filter zone. At detailed design the construction methods will be assessed to optimise the thickness for the filter zones.

9.5 Drainage Zone

Essential components of the drain design follow procedures used for the filter with the following modifications:

- The base soil for the drainage material is the fine limit of the filter material (Table 23).
- The regraded base soil (fine limit of filter) contains less than 15% fines. The base soil is therefore assigned Base Soil Category 3.

Table 24 lists the design drain grading envelop as shown in Figure 18.

Table 24 Drainage Zone Grading Envelop

Drain Grading Envelop		
Particle Size	**Percentage Passing (%)**	
(mm)	Fine	Coarse
90.00	100	100
40.00	100	60
30.00	100	
15.00	60	
12.00		15
10.00		10
5.00		0
4.00	15	
3.00	10	
0.900	2	

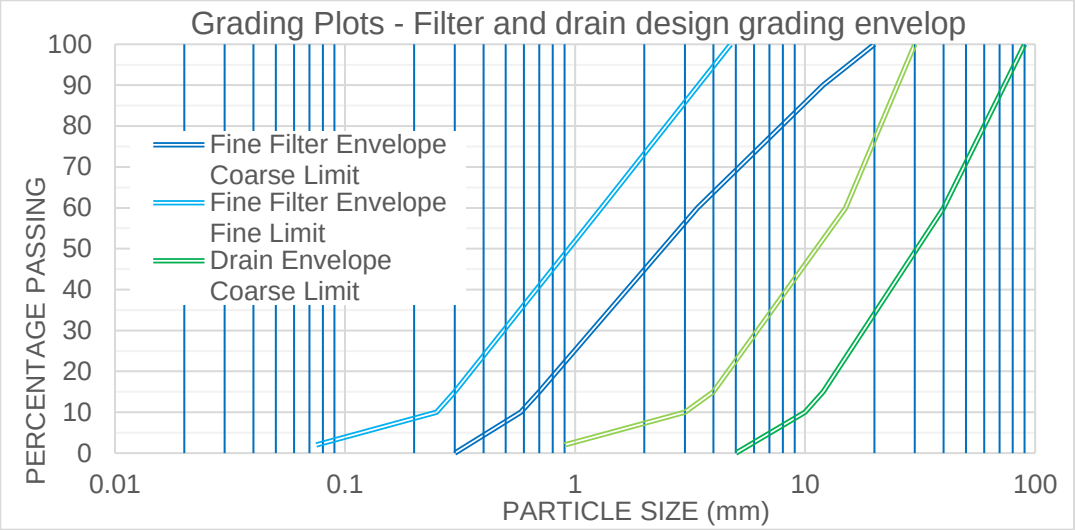


Figure 18 Design Grading Envelop of the Filter and Drain

9.6 Seepage Analysis

The purpose of the seepage analysis is to:

- Understand piezometric pressures with a compromised geomembrane liner.
- Assess the embankment performance under rapid drawdown conditions.
- Determine if the filter and drain perform per design intention.
- Estimate leakage discharges at the downstream toe.

The following design conditions were analysed:

- Case 1: Intact geomembrane condition with no leakage or seepage from the pond into the embankment.
- Case 2: Compromised geomembrane (i.e., no geomembrane modelled) and free seepage from the pond into the embankment.

- Case 3: Rapid drawdown under normal operations and emergency conditions with compromised geomembrane liner.

For all seepage analyses the groundwater levels is modelled at 119 m RL within the reservoir (upstream boundary) and at 112 m RL on the downstream boundary. The downstream boundary ties in with the Ōhau River level. The groundwater levels are based on piezometric measurements taken over twelve months in BH1 and BH3.

For all seepage analysis cases, the reservoir is modelled at full supply level (FSL). In Case 3 rapid drawdown, the reservoir at FSL is the initial condition, and then lowered to reservoir base.

9.6.1 Methodology

The maximum embankment fill height was considered for the assessment of seepage using the two-dimensional finite element seepage analysis program Seep/W® software. The analyses require estimates for the hydraulic conductivity of the embankment bulk fill, filter, drain and foundation soils (Table 25).

- **Horizontal permeability** for each material:
  - Compacted processed granular soils (i.e., filter and drain) is based on Sherard's empirical equation for granular filters (Sherard, Dunnigan, & Talbot, 1984);
  - Foundation Alluvium Terrace soils, is based on in-situ infiltration testing (Damwatch, 2021).
  - Older Alluvium and bulk fill, is based on literature for similar soils and characteristics.
- **Anisotropy**: is based on anticipated as-constructed conditions and guidance from previous similar projects.
- **Saturated water content**: Saturated water content is a parameter for estimating for partially saturated hydraulic conductivity characteristics. The water contend is equivalent to porosity and are adopted from literature.

Table 25 Summary of hydraulic conductivity parameters

WC Function	Water Content	Compressibility mv (kPa^{-1})	Residual water content	Kh m/sec	Kv m/sec	Ratio kh/kv
Bulk Fill	0.30	1.00E-05	0.030	1.00E-03	1.00E-04	10
Drainage	0.20	5.20E-06	0.020	5.60E-02	2.80E-02	2
Filter	0.43	2.10E-05	0.045	6.86E-05	6.86E-05	1
Soil (Alluvium Terrace &	0.35	1.00E-05	0.035	1.54E-06	1.54E-07	10
Clay (Older Alluvium)	0.38	2.60E-04	0.068	1.00E-07	1.00E-07	1

9.6.2 Case 1: Intact Geomembrane

Case 1 represents the normal operational conditions with the geomembrane fully functional and no seepage into the embankment. The groundwater level is at the surface on the upstream side of the model, approximately 2 m below the foundation level at the embankment centreline and ~112 m RL at the downstream end of the model (Figure 19).

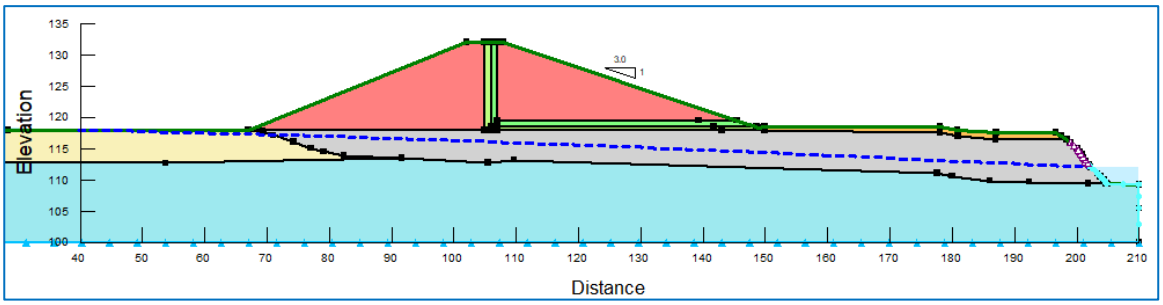


Figure 19: Steady State Seepage with Intact Geomembrane

9.6.3 Case 2: Compromised Geomembrane

Case 2 (Figure 20) represents the case where the upstream geomembrane is compromised due to a significant tear caused by external factors or earthquake ground motions. In the extreme the liner is assumed to be fully compromised and offers no obstruction to water entering the upstream shoulder. This condition is the basis for the steady state seepage analysis and has the following features.

- The upstream shoulder is saturated to the vertical chimney drain.
- The horizontal drainage blanket is saturated.
- There are local saturated lenses within the downstream shoulder, but these have low piezometric pressures.

The resulting piezometric pressures of Case 2 are consistent with the inclusion of the filter and drainage zones with sufficient capacity to maintain predominately unsaturated downstream shoulder conditions. Estimated discharges at the downstream toe is around 5 l/s/m.

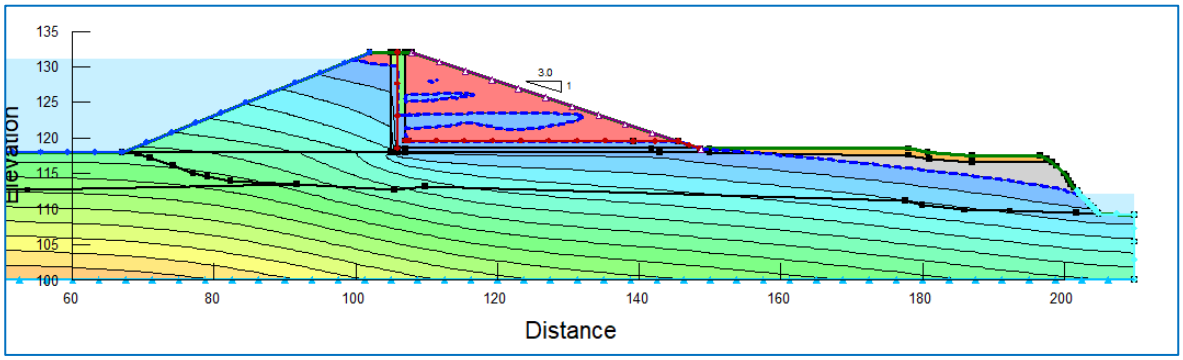


Figure 20: Steady State Seepage with Compromised Geomembrane

9.6.4 Case 3: Rapid Drawdown

While there is a fully intact liner system a rapid drawdown of the reservoir does not result in excess pore pressures within the embankment and the drawdown does not decrease the stability of the upstream slope. Thus, no seepage analysis or stability analysis is necessary for this scenario.

However, should the liner be compromised, and a rapid drawdown occur at the same time then excess pore pressures exist in the upstream shoulder of the embankment. The rapid draw down is represented by an initial condition with the reservoir set at full supply level, which is then drawn down to the base of the reservoir. The speed at which the reservoir is drawn down is significant in assessing the potential stability of the upstream shoulder:

- Normal operational dewatering with an estimated extraction rate of 300 mm/day. At this rate the reservoir could be lowered in approximately 37 days. The upstream shoulder has a relatively high hydraulic conductivity which promotes drainage. Consequently, the phreatic surface within the embankment lower at the same rate as the water level in the reservoir. Thus, dewatering the reservoir in these circumstances do not alter the stability of the upstream shoulder.
- Dewatering under emergency conditions where there is a sudden lowering of the reservoir very rapidly, hypothetically in less than an hour. This is a very unlikely circumstance, but its analysis does represent the most demanding circumstance. Figure 21 shows the phreatic surface within the embankment under emergency drawdown.

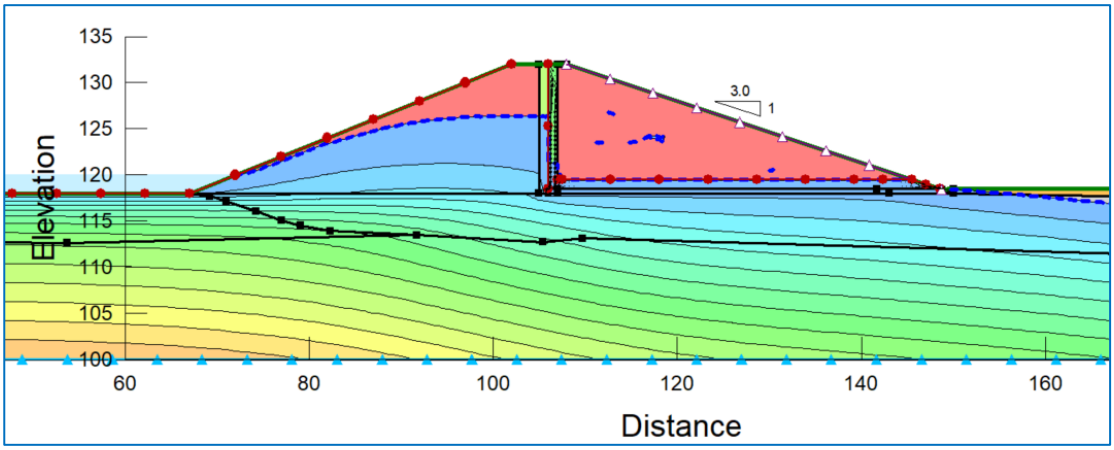


Figure 21: Rapid Drawdown under Emergency Dewatering

9.7 Embankment Stability

9.7.1 Embankment Geometry

The critical section for stability assessment (Section A-A) is on the alignment of maximum fill height, at the north side of the reservoir (Figure 22). Embankment internal slope is at 2.5H:1.0V and the external slope is at 3.0 H:1.0V (Table 26).

At other embankment fill sections are significantly lower and therefore more stable. At these locations the external slope 2.5H:1.0V. Given the low height of the embankment in these areas, and their inherent stability, their stability are not assessed.

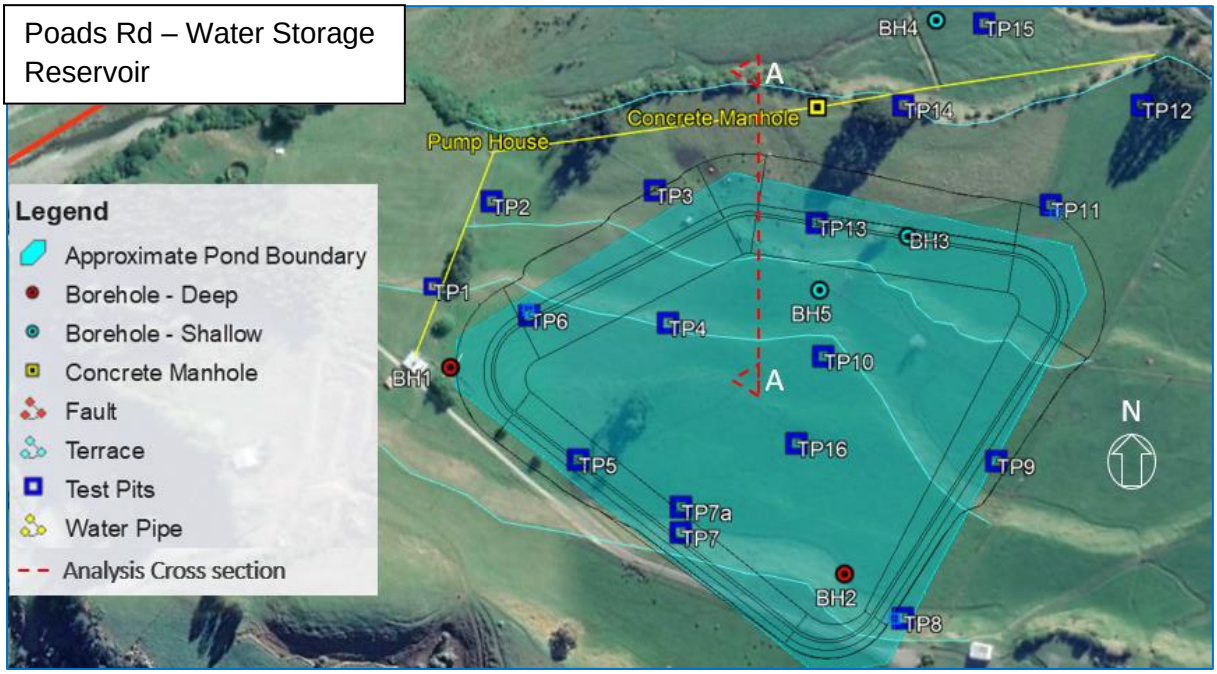


Figure 22: Critical embankment section along the maximum fill height.

Table 26 Summary of slope stability model geometry

Geometry	Value
Crest elevation	132 m RL
Crest width	6 m
Upstream slope	2.5 H:1V
Upstream ground level	118 m RL
Downstream slope	3.0 H:1V
Downstream ground level	117 m RL

9.7.2 Groundwater and Embankment Pore Pressures

The stability analyses adopt groundwater conditions and porewater pressures consistent with the conditions for each analysis case.

For those cases where the liner is intact, the reservoir is modelled as a surcharge load with no porewater pressures in the embankment. Normal operations with fully functioning (intact) geomembrane liner condition:

- End of Construction (EOC).
- Long-term steady state seepage.
- Unusual static with reservoir at the Inflow Design Flood (IDF).
- Rapid drawdown with normal operational dewatering.
- OBE.

For the case of a compromised geomembrane liner, the embankment porewater pressures were estimate from finite element seepage analyses. The pore pressures from the seepage analyses were imported to the slope stability model. Compromised geomembrane with free seepage into the embankment:

- Long-term steady state seepage.
- Extreme static with reservoir at the IDF.
- Rapid drawdown with normal operational dewatering.
- Rapid drawdown with emergency dewatering.
- SEE (mainshock).
- SEE aftershock.
- Post-earthquake (static).

The inflow design flood (IDF) is with the reservoir at 131.3 m RL.

9.7.3 Slope Stability

All major zones (bulk fill, vertical and horizontal filter and drain, and the underlying geological units) are included in the slope stability model. However, the upstream liner system and crest road materials are not individually identified as materials in the stability model.

Two-dimensional limit equilibrium method (LEM) analysis provided the basis for an assessment of the embankment's stability. The slope stability analysis was performed using SLOPE/W®

software. The Morgenstern and Price method is used for all the stability analyses in combination along with the block specified and entry/exit methods to identify the critical slip surface. Specifically, the upstream and downstream global slip surface that would result directly in the release of the stored water was analysed.

Static stability Cases: All static cases meet the NZDSG stability criteria (Table 27).

- End Of Construction (EOC).
- Long-term steady state with an intact geomembrane liner system on the upstream face.
- Water level in the reservoir representing the flood event elevation for the inflow design flow (IDF).
  - Unusual static with intact geomembrane.
  - Extreme static with compromised geomembrane.
- Rapid drawdown.
  - Intact geomembrane.
  - Compromised geomembrane with operational dewatering at 300 mm/day.
  - Compromised geomembrane condition with emergency dewatering.

Table 27 Factor of Safety for Static Cases

ID	Condition	Liner	Water level	FoS[1]		Criterion FoS
				U/S	D/S	
1	End of Construction	Intact	N/A	2.99	3.59	1.3
2	Long-term (static)	Intact	FSL			1.5
3	Flood - Unusual static	Intact	FSL+IDF			1.5
4	Flood - Extreme static	Compromised	FSL+IDF	4.1	3.18	1.5
5	Rapid drawdown (normal ops)	Intact	FSL	2.99		1.2 - 1.3
6	Rapid drawdown (normal ops)	Compromised	FSL	2.61		1.2 - 1.3
7	Rapid drawdown (Emergency drawdown)	Compromised	FSL	1.39		1

Note 1 Calculated FoS

Seismic Cases. Table 28 provides the result of the stability analysis for the OBE, SEE (mainshock), SEE aftershock, and a post-earthquake (static) condition.

- OBE loading with an intact geomembrane condition.
- SEE (mainshock) with an intact geomembrane condition.
- SEE Aftershock with a compromised geomembrane condition.
- Post-earthquake static with a compromised geomembrane.

Under the SEE mainshock case, the upstream shoulder has a FoS of 1.10 and meets the NZDSG performance criterion. However, the downstream shoulder has a FoS of less than 1.0. The ground acceleration is 1 g and the yield acceleration of the shoulder is estimated to be 0.6 g therefore suggesting some deformations can be expected as a result of SEE.

Under the aftershock, the upstream and downstream slopes have a FoS< 1.0. This suggests deformations are expected in an aftershock peak ground acceleration of 0.68 g.

A yield acceleration (ky) of 0.46 g and 0.48 g is estimated for the upstream and downstream slopes, respectively.

Under the post-earthquake (static) condition (following the SEE aftershock), the upstream and downstream slopes have a FoS of 3.81 and 3.02, respectively. A FoS > 3.0 exceeds the minimum NZDSG criterion of FoS = 1.2 to 1.3 for post-earthquake (static) loading.

Table 28 Factor of safety and ky value under earthquake conditions.

ID	Condition	Liner	kh	ky	FoS[1]		Criterion FoS
					U/S	D/S	
1	OBE	Intact	0.55 g		1.91	1.08	1 Only minor repairable damage
2	SEE mainshock	Intact	1.00 g	0.60 g	1.1	<1.00	No uncontrolled release
3	SEE aftershock	Compromised	0.68 g	0.46 g** 0.48 g***	<1.00	<1.00	
4	Post-earthquake (SEE mainshock & aftershock) static	Compromised			3.81	3.02	1.2 – 1.3

Note 1 – Calculated FoS
** Upstream
***Downstream

9.8 Seismic Deformation

In those seismic cases where the calculated factor of safety of the embankment is below unity seismic-induced deformations are possible and these deformations are a combination of:

- Deviatoric deformations are associated with shearing along a slip surface. These are exhibited as slumping in the horizontal and vertical directions. Deviatoric deformations estimates use semi-empirical methods by Bray and Macedo (Bray & Macedo, 2019). The methods consider the dynamic nonlinear response of the embankment and slope displacements for near-fault ground motions.
- Crest settlements resulting in a net loss of freeboard due to vertical movement and volumetric compression. Crest settlements are estimated as the sum of the vertical component of deviatoric deformations and volumetric compression settlement.
- Volumetric compression settlement is estimated using methods by Tokimatsu and Seed (1984).

9.8.1 Deviatoric deformations

Input parameters for estimating deviatoric deformations from near-fault ground motions include:

- Yield acceleration (ky) for mainshock and aftershock (Table 15 and Table 29).
- Earthquake moment magnitude (M_w) (Table 14).
    - SEE Mainshock
    - SEE Aftershock
    - Embankment fundamental period (Ts) =2.6H/Vs. The fundamental period is based on the maximum slip surface height (H) and embankment shear wave velocity (V_s), which is taken as 300 m/s for well compacted gravel fill.

- Spectral acceleration at degraded period [Sa(1.3Ts)]. The spectral acceleration at degraded period [Sa(1.3Ts)] requires the response spectra for the SEE and aftershock, which are developed from the methods in NZTA Bridge Manual (NZTA, 2013).
- Peak ground velocity (PGV) of 121 cm/s and 70 cm/s, which are estimated using the methods by Bray et. al. (2009). Inputs include earthquake magnitude M_w, distance, and the site foundation type (soil or rock).

The vertical component of the deviatoric deformations is prorated trigonometrically using the downstream slope angle of 1.3 H:1 V and accounts for 60% of the total deviatoric deformations.

The estimated total deviatoric deformations for the SEE mainshock and aftershock is 140 mm for the upstream slope and 410 mm for the downstream slope (Table 29). The maximum deviatoric deformation of 410 mm is used to assess the embankment seismic performance. Negligible deformations are expected for the upstream slope under the mainshock based on a FoS of 1.10.

The estimated vertical component of deviatoric deformations for the downstream slope is 89 mm under the SEE and 40 mm for the aftershock for a total of 129 mm. The estimated vertical component of deviatoric deformations for the upstream slope is 52 mm as a result of an aftershock.

Table 29 SEE Mainshock and Aftershock Deviatoric Deformations

Slope	ky	PGV	Sa (1.3Ts)	Deviatoric Displacement*	Vertical component
	(g)	(cm/s)	(sec)	(mm)	(mm)
SEE Mainshock					
Downstream	0.6	121	1.78	283	89
SEE Aftershock					
Upstream	0.46	70	1.33	140	52
Downstream	0.48	70	1.35	127	40
Total					
Upstream				140	52
Downstream				410	129

* The estimated deviatoric deformations are presented as mean plus one standard deviation.

9.8.2 Seismic Volumetric Compression Settlement

Seismic volumetric compression settlement was estimated using methods by Tokimatsu and Seed (1984) for unsaturated (mainshock) and saturated (aftershock) sands. The amount of volumetric compression depends on the density of the material, the amplitude of the cyclic shear strain and earthquake loading.

Table 30 lists the estimated seismic volumetric compression from the SEE mainshock and aftershock loading. Volumetric compression is estimated to be 29 mm under the mainshock and 10 mm under the aftershock.

9.8.3 Crest Settlement

Crest settlement was taken as the sum of the vertical component of the deviatoric deformations and the volumetric compression. Table 30 summaries the total crest settlement from the mainshock and aftershock loading and the respective post-earthquake freeboard.

Deformations associated with the downstream slope results in crest settlement of 168 mm compared to the 62 mm associated with the upstream slope. The post-earthquake (SEE mainshock and aftershock) freeboard is 832 mm based on the downstream slope deformations.

Table 30 Estimate Crest Settlement and Post-Earthquake Freeboard

	Upstream Slope		Downstream Slope	
Mainshock (Mw 7.5)				
Vertical Component	0		89	
Compression Settlement	0		29	
Mainshock Settlement		0		118
Aftershock (Mw 6.5)				
Vertical Component	52		40	
Compression Settlement	10		10	
Aftershock Settlement		62		50
Totals				
Total Crest Settlement		62		168
Post-Mainshock & Aftershock Freeboard		938		832

9.8.4 Embankment cracking

Typically, well compacted embankment dams constructed of well graded sandy gravels have a good seismic performance history and do not experience significant strength loss. Also, large slope displacements are not expected but surficial deformations and shearing is a more common result at the high accelerations of the extreme earthquake.

Nonetheless, severe seismic ground motions can induce longitudinal and transverse cracking in an embankment. Longitudinal cracks are associated with slope movement and are exhibited at the dam's crest. Transverse cracks across the embankment can develop an open leakage pathway across the embankment, which can potentially enlarge by erosion and down-cut though the embankment, leading to a breach of the reservoir. Transverse cracks can potentially develop across the dam crest, at concrete interfaces, or through the embankment where geometrical anomalies exist within the foundation or embankment.

The potential for longitudinal cracking is commonly qualitatively assessed by considering the Damage Class method by Pells and Fell (2002 + 2003) and the Geotechnical Engineering of Dams (Fell, MacGregor, Stapledon, & Bell, 2015). The method uses the Damage Class to

provide guidance on cracking based on dam case histories subject to earthquake loading (Table 31).

Figure 23: Contours of Damage Class for Earth and Rockfill Dams illustrates the Damage Class contours for earth and rockfill dams-based on the PGA and earthquake M_w. The maximum PGA of the empirical method is 0.9g. Inherently this plot includes damage associated with aftershocks depending on when they documented of dam case histories.

Table 31: Damage Classification System

Damage Class		Maximum Longitudinal Crack Width (mm)	Maximum Relative Crest Settlement (%)
Number	**Description**		
0	None or slight	< 10	< 0.03
1	Minor	10 - 30	0.03 – 0.2
2	Moderate	30 – 80	0.2 – 0.5
3	Major	80 – 150	0.5 – 1.5
4	Severe	150 – 500	1.5 – 5
5	Collapse	> 500	> 5

The dam case histories are generally for dams of moderate heights; 30 m to 60 m. Experience suggests this method of normalised crest settlement by embankment height tends to overestimate deformations and cracking for short embankments such as the Poads Road embankment. Thus, the following presents this approach for comparison purposes only.

For the mainshock (Mw 7.5 and PGA of 1.0 g) there is no data in the range, however it would fall within the estimated Damage Class is 3, Major Corresponding longitudinal crack widths are in the order of 80 - 150 mm.

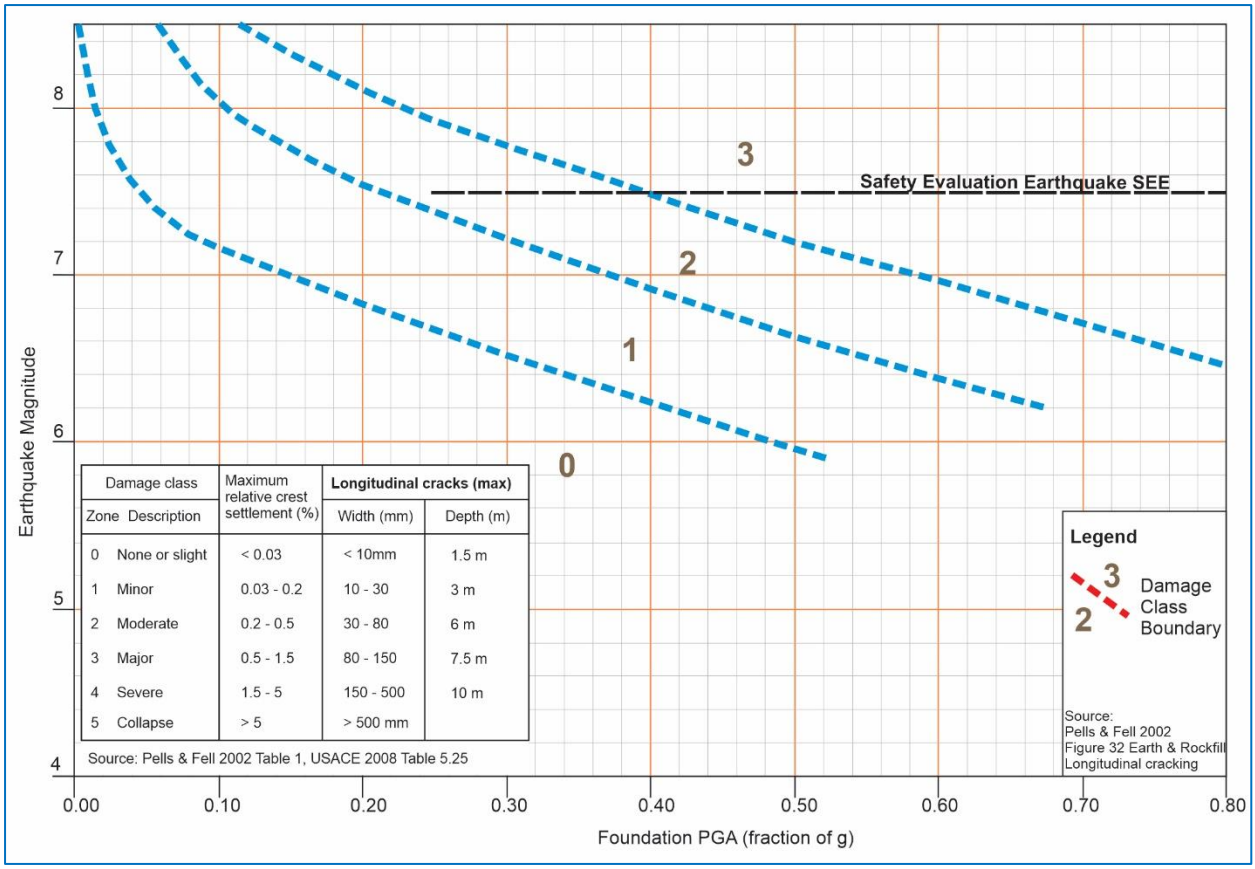


Figure 23: Contours of Damage Class for Earth and Rockfill Dams

There are few historical cases of transverse cracking on embankment dams, and very little data directly applicable to embankments enclosing reservoirs. The assessment of the potential for transverse cracking for the reservoir embankment considers possible initiating mechanisms.

- No geometric anomalies within the foundation and therefore foundation differential settlement is expected to be minimal, even when including possible the effects of liquefaction/cyclic softening. Thus, no transverse cracking is expected to initiate from the foundation.
- There are however geometric corners to the embankment. Differing shaking modes can occur at corners and these might move outward under seismic shaking. Such movement within the cohesionless sandy gravel embankment fill is expected to be in shear rather than tension. Open transverse cracks are not expected to form, but localised zones of sheared embankment material may occur.

9.9 Embankment Toe Unravelling

If the geomembrane liner system on the upstream face of the embankment is breached seepage flow can enter the upstream shoulder of the embankment and migrate towards the central chimney drain. This flow would not compromise the stability of the embankment in normal operation. The chimney drain and blanket toe drain are intended to discharge the full seepage flow that might enter the upstream shoulder without compromising the stability of the embankment. Monitoring of the drainage systems would identify the anomaly and there would then be time to investigate and correct a failure of the liner system.

Thus, redundancy and resilience are built into the arrangements for the embankment. As a consequence of these measures, uncontrolled seepage flow in the downstream shoulder is not anticipated and no unravelling of the downstream toe is expected. However, this mechanism will be revisited in the detailed design.

9.10 Preliminary Performance Assessment

The preliminary slope stability analyses provide a screening assessment of the embankment performance under the design loading conditions.

The assessment indicates that the embankment meets the NZDSG performance criteria:

- Static Conditions: Meets all the static performance requirements for the various static loading conditions.
- Seismic OBE: Meets the stability performance requirement without movement or settlement.
- Seismic SEE and Aftershock: Meets the performance requirement with limited movement which is not likely to breach of the embankment.

Various defensive measures are incorporated within the embankment to provide resilience in extreme static and seismic conditions.

The preliminary limit equilibrium analyses performed for the feasibility design completes the first step and serves to inform the next step. The NZDSG design practice recommends that analysis should progress to more sophisticated techniques to resolve uncertainty associated with the high seismic loads. Numerical nonlinear deformation analysis will provide robust estimates of seismic embankment displacement to assess potential cracking and increased confidence in the embankment seismic performance.

The output from the NZNSHM2 will require further investigation at detailed design to refine and define the seismic loads. Following which more sophisticated methods may be warranted to assess the stability of the embankment. Once these assessments are progressed, the embankment may require additional geosynthetic reinforcement, or other defensive measures, to increase the ability of the embankment to withstand extreme seismic motions.

9.11 Liner Stability and Anchor Runout

The low permeability element is an HDPE geomembrane placed on the upstream face of the dam. The stability of the liner system and the runout anchor is assessed in accordance with the methods provided by Koerner (1997) and Koerner and Soong (2005) (

Table 32).

The critical interface for stability is the contact between the cushion geotextile and the upper side of the textured geomembrane.

The stability of the geomembrane liner system meets the NZDSG (Module 3, Table 6.3) stability criteria for the embankment slopes.

Table 32: Liner Geomembrane Arrangement

Parameter	Value
Geomembrane	HDPE 1.5 mm (textured / textured)
Lowest level of riprap protection	128.50 m RL
Factor of Safety against sliding	1.55 > 1.5 OK (long-term static)
Runout anchor length	3.0m (FoS against pullout >1.1)

9.12 Hydrogeology Hillside Seepage

The southwestern excavation slope for the reservoir is about 380 m long and this slope intercepts a local groundwater regime in the shallow hillside to the southwest. An estimate of the possible groundwater flow intercepted by this slope is necessary for the definition of the groundwater collection system below the reservoir liner system. The flows are likely to vary through the seasons and constrained or governed by the variability of various factors. However, an accurate estimate is not required because the design of groundwater protection systems typically include various factors to account for variability and unknowns.

The shallow hillside groundwater regime is probably recharged primarily from rainfall surface infiltration. This infiltration is the net result of rainfall minus the runoff and the surface evaporation. Also, if the subsurface deposits are not able to convey the groundwater flows, the water rises to the surface and is discharged as surface water to ephemeral streams and drainage ditches.

The hillside rises to approximately 145 m RL at the midpoint between the reservoir cut slope and the right bank of the Makaretu Stream, where the ground level is approximately 118 m RL. The distance across the hillside at a representative section is approximately 570 m. Given the regularity of the surface conditions, pasture, across the divide and presuming the terrace formation is consistent in the area, then the groundwater regime probably discharges similar flows to the Makaretu Stream and to the reservoir's southwestern boundary. The other factor is the possible horizontal permeability of the terrace gravels, which is based on the analysis of falling head tests in BH01.

Based on this understanding of the groundwater, and a synthesised monthly rainfall based on the average annual rainfall for Levin, the groundwater flows to the reservoir, along the 380 m long excavation face, could be in the order of:

- 27 m^3 /day - Daily average through the year.
- 42 m3 /day – Daily flow in a typical winter season.
- 14 m3 / day – Daily flow in a typical summer season.

These approximate numbers provide a basis for the design capacity for the reservoir liner's groundwater protection system.

9.13 Groundwater Drainage Systems

Continuous geosynthetic liner systems are vulnerable to damage from groundwater uplift when the water level within the reservoir is lower than the external groundwater level. Therefore, the groundwater collection system below the liner system must prevent hydraulic uplift and accommodate the inherent unknowns in the groundwater regime characteristic and behaviour:

- The Terrace Alluvium probably consists primarily of granular materials allowing vertical percolation of groundwater throughout most the deposit. However, the depositional processes have probably also resulted in hydraulic conductivities that are greater in the horizontal than in the vertical directions, and there will be location promote preferential flow paths along old, buried water courses. Thus, groundwater flow along the southwestern interface with the underside of the liner system will not be consistent along this boundary.
- The Older Alluvium has layers of low permeability clays which inhibit vertical drainage. Therefore, groundwater collected at the reservoir boundaries and from any local groundwater regime below the base of the reservoir may not drain vertically away from the reservoir's liner system.

To protect the liner system, address unknowns in the groundwater regime as well as the potential impediment for vertical drainage away from the base of the liner system, the groundwater collection system below the liner incorporates various factors of safety and built in redundancy. The liner system is protected by a groundwater collection system incorporating:

- A geocomposite drainage systems on the excavation face for the reservoir, which is installed over the formation and below the liner system.
- A granular drainage blanket across the base of the reservoir to prevent uplift below the liner system.
- A series of perforated groundwater collection pipes placed within the granular drainage blanket to convey the collected groundwater to the downstream toe of the embankment for discharge.

10.0 Wind Generated Waves and Armour Protection

10.1 Introduction

The main processes potentially affecting the dam face are wind-generated waves, wave setup and wave run-up. The riprap on the face of the dam to resist wind generated waves is designed in accordance with the following standards and references:

Wind climate and loading:

- AS/NZS 1170:2002 Structural Design Actions: Part 2 Design wind. (2002)

Wave climate:

- Goda Y "Revisiting Wilson's formulas for simplified wind-wave prediction" ASCE J. Waterway, port, coastal and ocean engineering March/April 2003 pp 93-95. (2003)
- Young I R, Verhagen L A (1996) “The growth of fetch limited waves in water of finite depth" Elsevier Science B.V “Coastal Engineering" 47-78. (1996)

Wave setup:

- CIRIA "Rock manual - The use of rock in hydraulic engineering" C683 Section 4 pp 326. (2007)
- Fell R, MacGregor P, Stapledon D, Bell G (2015) "Geotechnical Engineering of Dams" A.A. Balkema ISBN 04 1536 440 X pp 538.
- Novak P, Moffat A I B, Nalluri C, Narayanan R (1990) "Hydraulic structures" Unwin Hyman ISBN 0 04 627011 6 pp 147.

Wave runup:

- Van der Meer J W, Stam C J M (1992)"Wave run-up on smooth and rock slopes of coastal structures" ASCE journal of WPC&OE, vol 118, (5) pp534-550.

Riprap:

- Van der Meer (1988) – USACE (2002) “Coastal Engineering manual” Chapter 5 EM 1110-2-1100 Fundamentals of Design (Part VI) pp 5-66 Table VI-5-23.
- Fell R; MacGregor P, Stapledon D, Bell G, Foster M (2015) “Geotechnical Engineering of Dams”. CRC Press. Kindle Edition. pp 784.
- NCHRP (2006) "Riprap design criteria, recommended specifications and quality control" Report 568 pp 75.

10.2 Wind Climate

Estimates of extreme wind speeds are derived from AS/NZS 1170.2:2002 (2002) and converted to mean 10-minute wind speeds via empirical methods contained in the USACE (2002).

The significant fetch affecting the dam is at right angles to the dam and from the south.

Table 33: Wind Climate

Parameter	Value	Reference
Design criteria	1 : 100 AEP	Table 2.1
Fetch length	500 m	
Fetch direction	Southerly	
Region	NZ2	NZS1170 Part 2
Regional wind gust speed	42 m/s	NZS1170 Part 2
Desired height of windspeed	10 m	For wave climate formula
Site wind gust speed (with multipliers)	42 m/s	NZS1170 Part 2
Minimum duration to fully develop waves	13 mins	USACE (2003)
Design wind speed (U_{10})	25.4 m/s	Wilson formula (Goda 2003)

10.3 Wave setup

The shear stress exerted by wind on the water surface causes a slope in the water surface, as a result of which wind set-up occurs at the downwind boundary, the dam face. To produce this set-up the wind must blow for a certain time; the shorter the fetch and higher the wind speed, the short the time required to develop the setup. For small reservoirs the setup is typically small, this is confirmed by estimates using three methods (Fell, MacGregor, Stapledon, & Bell, 2015).

Table 34: Wave Setup at Embankment Face

Parameter	Value	Reference
Design wind speed (U_{10})	25.4 m/s	Table 32
Wave set up	7 mm	Fell (2015)

10.4 Wave climate

Fell (2015) provides a method for assessing the wave climate. The normal top water level and fetch are adopted for assessing the wave climate.

Table 35: Wave climate at Embankment Face

Parameter	Value	Reference
Design criteria	1 : 100 AEP	NZDSG
Water depth average	10 m	Reservoir geometry
Wave period	1.4 sec	Fell (2015)
Significant wave height	395 mm	Fell (2015)
Top 10 % wave height	501 mm	Fell (2015)

10.5 Wave runup

Runup on rock armoured impermeable and permeable slopes is assessed with the method reported by Fell (2015). The equation for runup is valid for relatively deep water in front of a structure where the wave height distribution is close to the Rayleigh distribution. Wave breaking on a foreshore results in a truncation in the runup distribution which mainly results in lower runup heights for small exceedance probability levels.

Table 36: Wave Runup on Embankment Face

Parameter	Value	Reference
Revetment type	Permeable, Riprap	
Revetment slope	1 : 2.5	Upstream embankment face
Runup of significant wave height	388 mm	Fell (2015)
Runup of top 10% of waves	492 mm	Fell (2015)
Runup of top 5% of waves	**543 mm**	Fell (2015)
Runup of top 1% of waves	647 mm	Fell (2015)

10.6 Rip-rap protection

Van der Meer (1988) (USACE, 2006) provides a procedure for the design of a riprap revetment over an impermeable layer where no overtopping is anticipated, and the waves are head on to the revetment. The procedure is for the design of a two-layer riprap system; the secondary lower layer is provided by a geotextile that also acts as protection to the geomembrane (USBR, 2014).

NCHRP (2006) procedures provide the minimum thickness of the riprap layer and grading envelops for the riprap stone size.

Table 37: Upstream Face Armour

Parameter	Value	Reference
Unit weight of rock	23 kN/m^3	USACE (2006) Table VI-4-3
Damage level (only slight at design wave)	S = 2	USACE (2006) Table VI-5-21
Notional permeability	Armour over impermeable layer	USACE (2006)
Number of waves to equilibrium damage	7500	USACE (2006)
Waves	Deepwater	USACE (2006)
Wave impingement type	Plunging waves	USACE (2006)
Size of rip rap	D_{50} = 145 mm	USACE (2006) (Eq VI-5-68)
Weight of rip rap	M_{50} = 7.15 kg	USACE (2006)
Size of rip rap (max)	D_{85} = 237 mm	NCHRP (2006)
Type of stone	Rounded	River gravel (conservative)

Minimum thickness of riprap	290 mm minimum	USACE (2006) pp VI-5-16
Minimum average thickness of riprap	300 mm minimum	Fell (2015) pp784
Minimum thickness of riprap	435 mm minimum	NCHRP (2006)
Adopted thickness of riprap	**400 mm**	
Rip rap uniformity coefficient (1.25 - 2.5)	1.590 < U < 1.712	NCHRP (2006)

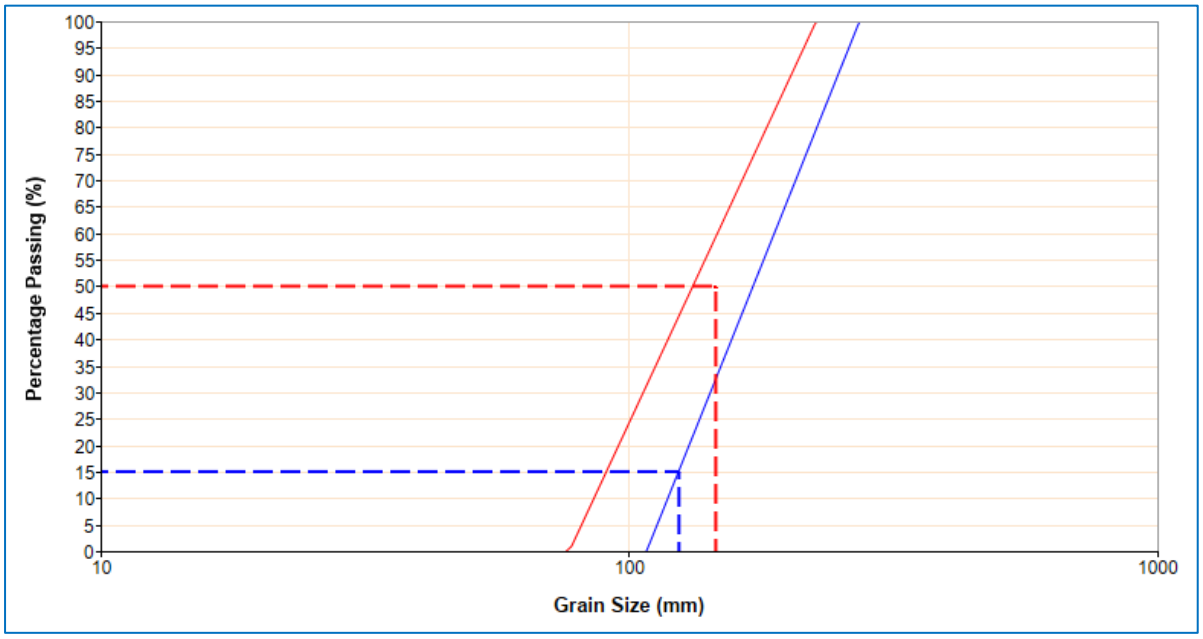


Figure 24: Riprap particle size distribution

10.7 Geosynthetic Cushion Geotextile

A cushion geotextile acts as the secondary layer for the riprap and provides damage protection to the geomembrane below. Pilarczyk (2000) indicates for most revetments of rounded stone, the penetration of a geotextile by wave action is not decisive for determining the specification of a geotextile.

The determining factor occurs during placement of the riprap from a back-actors bucket, and the significant factor is the height from which the stone is dropped. Lawson (1992) developed a formula for estimating the necessary unit weight of a geotextile as a function of the characteristic stone diameter and the fall height.

Table 38: Cushion geotextile

Parameter	Value	Reference
Fall height	2m	Dependent on the contractor's back-actor operator
Characteristic stone size	D_{85max} = 155mm	
Factor for no damage when bulk dumping	1.2	Lawson (1992)
Geotextile weight per metre squared	Min 263 grm / m^2	Lawson (1992)

10.8 Summary

The riprap on the upstream face of the embankment has several functions:

- Reduction of wave runup to minimise the height of the embankment.
- Protection of geomembrane against UV light to extend the life of the liner.
- Protection of geomembrane against diurnal temperature variations and frost to extend the life of the liner.
- Provide a means for people to climb out of the reservoir should they fall in by accident.
- Protection of the liner system against accidental damage, vandalism.

The rip rap is intended to be stable in normal static conditions and waves generated on the reservoir. The riprap arrangement adopts rounded stone, which is larger than the equivalent necessary for angular stone, but rounded stone is more likely to be processed from the excavated terrace gravels, thereby reducing imported riprap.

The riprap does not provide a dam safety function during or immediately following an earthquake. It is also not intended to resist the action of a seiche generated on the reservoir during earthquakes. Therefore, the riprap is not intended to be stable in high magnitude earthquakes. After an earthquake, inspections should identify areas of dislodged riprap and reinstatement can be planned at that time.

11.0 Spillway and Floods

11.1 Introduction

Reservoir Spillways protect the dam embankment by discharging excess flood water before it overtops the dam, and the spillway's crest level is set to maintain adequate freeboard in a design flood condition. In addition, the spillway, in combination with other outlet works, allows for the lowering of the reservoir in emergency conditions.

Thus, a spillway performs essential dam safety functions and NZDSG defines a spillway as an appurtenant structure. As such the NZDSG sets minimum requirements for spillways in times of flood and earthquakes.

Spillways discharge water from the Poads Road reservoir to a natural water channel, in this case the Ōhau River. Any discharge to a river requires a resource consent under the RMA. Thus, it is important to clearly define the flows and conditions under which water is discharged from the spillway to the water course. Typically, the locations, magnitude and circumstances of water discharges are different during construction and operation of the reservoir.

Other discharges and discharge locations from the site may also require resource consent and are considered separately.

The spillway is configured to allow passive discharge of floods; no gates need be opened to discharge flow. It consists of the following components:

- A spillway crest across the embankment crest.
- A concrete beam set into the spillway crest to define the flow section.
- A trapezoidal chute conveying water down the hillslope and across the river terraces towards the Ōhau River.
- Energy dissipation structures on intermediate river terraces and at the discharge point to the Ōhau River.

11.2 Performance requirements

The reservoir arrangements include a single primary spillway meeting all the performance requirement for the reservoir. However, the reservoir does not require an auxiliary spillway because:

- The dam's Medium Potential Impact Category (PIC), which requires a relatively high flow discharge criterion.
- The very limited catchment area, which limits the maximum flow entering the reservoir.

The performance requirements for the spillway are:

- Discharge of floods from the reservoir consistent with the PIC of the dam.
- Discharge excess flows that might occur from abstracting water from the river.
- Provide adequate and appropriate safety precautions for those personnel at the facility. These considerations assume that the site is provided with security fencing to exclude the public.

- Arrange the spillway crest so its level can the lowered by 900 mm at short notice and with elementary equipment that might be available on site or near site. Lowering the full supply level may be required following an earthquake.

11.3 Flood Flows Entering Reservoir

Estimates of flood flows entering the reservoir and their attenuation within the reservoir are the basis for assessing of a spillway size necessary to pass these flows in accordance with NZDSG.

There are two catchment components contributing rainfall to flood flows. The catchment draining to the reservoir is ungauged, small and with no formal stream channel. The other component is the reservoir surface itself.

Flood flows entering the reservoir are assessed in accordance with the following standards and references:

Rainfall:

- NIWA (2018) "High Intensity Rainfall Design System Version 4" Envirolink August 2018 Report 2018022CH.

Climate change for extreme events:

- Ministry of the Environment (2018) "Climate Change Projections for New Zealand: Atmospheric projections based on simulations undertaken for the IPCC 5th Assessment 2nd Edition" ME 1385 ISBN 978-1-98-852587-7.

Antecedent flow in the catchment:

- ICE (1996) "Floods and reservoir safety" 3rd Edition Thomas Telford ISBN 07277 2503 3.
- Mansell M G (2003) "Rural and urban hydrology" Thomas Telford ISBN 0 7277 3207.
- Sutcliffe (1978) “Methods for flood estimation: A guide to the Flood Studies Report” Institute of Hydrology. Report No 49.

Time of concentration for the catchment, runoff coefficients and rational method for runoff:

- Gericke O J, Smithers J C (2016) "Are estimates of catchment response time inconsistent as used in current flood hydrology practice in South Africa" J South African Inst of Civil Engineers Mar 2016.
- Ven Tee Chow (1962) “Applied Hydrology”.

The design rainfall is based on data for the local area (Table 39).

Table 39: Rainfall records

Required information	Value	
Average annual rainfall (Climate-Data.Org)	Levin	
Depth Duration Frequency Model parameters HIRDS Version 4	Poads Road	Longitude: 175.3578 Latitude: -40.6555

The catchment characteristics for hydrological assessments include the physical dimensions, hydrological response and the potential effects of climate change (Table 40).

Table 40: Catchment Characteristics

Characteristic	Value
Average annual rainfall	923 mm
Area of reservoir	10.5 ha
Area of catchment excluding reservoir	7.5 ha
Catchment gradient	Approximately 1 : 20
Time of concentration (Bransby &Williams)	6.8 mins
Climate change scenario MoE 2018	RCP6.0
Projected temperature change MoE 2018 Table 14	2.3 Degrees Celsius
Projected percentage rainfall change per degree temperature change for extreme events MoE 2018 Table 13 linear interpolation.	13.6 %
Rainfall intensity for Duration = Time of Concentration	1 : 100 AEP = 383 mm / hr

Prior to an extreme rainfall event, prevailing wet conditions are likely to generate overland flow. In a small catchment the antecedent stream flow is typically insignificant and does not affect the sizing of a spillway structure. Nonetheless, an allowance for the antecedent flow is based on:

- Mean annual rainfall.
- Catchment wetness index (CWI), which is also a function of the mean annual rainfall.

11.4 Reservoir Attenuation

The catchment is ungauged. Thus, estimates for flood flow events are based on the Rational Method, incorporating the following (Table 41):

- Rainfall intensity for a storm duration that is the same as the time of concentration for the catchment.
- The estimation of the influence of climate change.
- The runoff coefficient, which is influenced by the gradient of the catchment and the rarity of the event; steep catchments and more extreme events have higher runoff coefficients.
- The area of the catchment.
- Attenuation through the reservoir using the Modified Pulse procedure (FHWA, 2001).

Table 41 Design peak flood flows

Parameter	Value	Reference
Antecedent flow	402 l/s	
Event	1 : 100 AEP	NZSOLD (2015) Module 3 Table 1
Runoff coefficient	0.49	Ven Te Chow (Pasture, av gradient, 1:100 AEP)
Climate change factor	1.313	MoE 2018 Table 13 - Linear interpolation 100yr ARI for 2.3°C temperature change.
Rainfall intensity	383 mm / hr	HIRDS Version 4 with Climate change
Peak inflow (catchment plus reservoir surface)	15.64 cumecs	Rational method
Attenuated discharge flow	1.61 cumecs	Using the Modified Puls method

11.5 Spillway Crest Arrangements

The arrangement for the crest of the spillway includes:

- An approach channel to reduce the head loss in the approach to the spillway. The depth provides an approach velocity to less than 0.3 m/s, for which the head loss in the approach is approximately 6 mm (the velocity head).
- A low reinforced concrete weir defines the full supply level and the live storage volume in the reservoir. The general arrangement of the weir is simple and regular throughout its length to minimise construction time and effort.
- The weir structure arrangement incorporates an interface with the low permeability upstream blanket on the upstream face of the embankment. This arrangement reduces the seepage beneath the weir and increase its stability.
- A discharge channel of shallow gradient to convey flood water away from the crest and embankment to the spillway chute.

The proportions for the concrete weir are based on:

- A weir crest length and crest elevation to match the hydraulic performance requirements. The elevation of the crest is set at 130.9 m RL with a length of 20 m to provide the necessary discharge capacity in the design flood event (Figure 25).
- A weir crest length and its relationship with the discharge channel to the spillway chute to minimise scour protection requirements. The weir crest is marginally longer than the length required to minimise the scour protection requirements for the structure.
- An upstream apron to attach the lining system to mitigate the effects of potential scour and undermining of the structure.
- An overall structure length to prevent high seepage exit gradients below the structure that induce loss of foundation soils. The length of the downstream apron is sufficient, in combination with the depth of the downstream cut-off, to reduce the seepage exit gradients to below the critical value for the estimated soil particle size of 0.3 mm.
- A downstream basin length that is sufficient to contain and control the hydraulic jump and energy dissipation.
- A minimum thickness for the downstream basin floor to resist uplift.

- A downstream apron of riprap to protect the structure from scour. To prevent soil movement from below the apron, the two are separated by a geotextile.

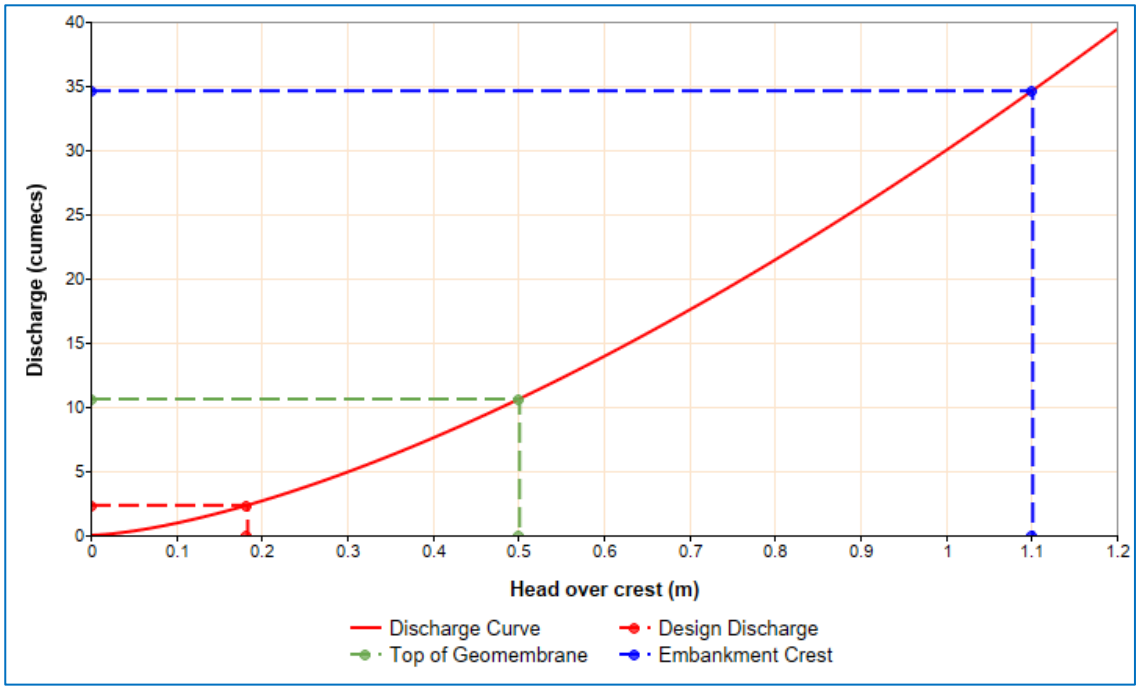


Figure 25: Spillway Weir Discharge Rating Curve.

11.6 Spillway chute

Various spillway chutes arrangements have been considered on the basis of technical suitability, expense and environmental considerations:

- Concrete chutes are a standard and traditional means of providing resilient channels for the discharge of high velocity flows. This type of chute has several disadvantages for this application; it is a rigid structure where a flexible structure is preferred, unnecessarily expensive, and it is environmentally less favourable than other options.
- Baffle channels have a considerable advantage in being able to dissipate energy progressively downs a slope. However, the USBR style structure is primarily formed of concrete, the channels are expensive to construct and are not environmentally favourable.
- Gabion mattress spillways have an advantage of dissipating flows through the stone fill, but they require a formation resilient to erosion, or protected from erosion. The mattresses tend to deform over time and the wire cages tend to deteriorate. Consequently, these spillways require long term maintenance and are less environmentally appealing than other options.
- Grass Spillway chute. A grass spillway is vulnerable to surface erosion and backward erosion at relatively low flows and flow velocities. A failure of a grass spillway could compromise the toe of the embankment and therefore is not adopted.
- Reinforced earth and grass spillway chute. Reinforced earth spillways are more resilient than grass alone. However, this type of lining has an upper bound of operational velocity and flow.

- Incomat is a form of filled mattress which is resilient to high flow. The external fabric of the mattress is also able to support grass growth. For these reasons Incomat is adopted as the primary lining system for those sections of spillway chute with high velocity flows.

The feasibility design adopts a combination of spillway linings:

- Incomat in the upper zones of the spillway chute, where the flow velocities are high, and the alignment is adjacent to the reservoir embankments. The failure of other less resilient linings in this zone could compromise the toe of the embankment.
- Where the spillway chute crosses the lower terraces and the gradient is shallow, the flow velocity is also reduced substantially. In this zone the chute can be lined with grass reinforced with a geosynthetic fabric to inhibit erosion and backward erosion.
- Transitions between flow regimes and chute lining types require details to prevent initiation of degradation. At these points energy dissipation and transitions zones are provided.

11.7 Gabion Energy Dissipation Structure

The spillway must discharge from the lowest river terrace, down the steep left bank of the river to the riverbed. This zone is subject to two main hydraulic forces that can cause progressive damage to this lowest extent of the spillway:

- The hydraulic shear and turbulence in the river at high flows and general migration of the river course that could undermine the toe of the spillway and destabilise the riverbank on either side.
- The high velocity spillway discharge as it descends the steep riverbank. Without protection this flow could cause progressive backward erosion in the terrace and undermining of the toe of the riverbank.

To mitigate both these effects, this lowest part of the spillway should be armoured with gabions on either side combined with gabion mattresses in the main spillway channel.

11.8 Freeboard Criteria and Requirements

The crest level accounts for reservoir storage, flood rise, wave height, wave run-up, set-up and freeboard requirements. NZDSG provides three guideline criteria for setting the crest elevation (NZDSG Module 3 Table 1).

The NZDSG Module 3 Table 1 guideline is relevant to large embankment dams where the top of the core can be vulnerable to erosion if water passes through the upper portion of the crest. Sustained erosion could damage and compromise a core. However, the Poads Road reservoir arrangement provides a high integrity liner system this dam a high degree of integrity is provided with a geomembrane extending to within 800 mm of the crest level.

Table 42: Performance Criteria for Low, Medium and High PIC Dams

Event or element	Performance criteria	Value		
		Low PIC	Medium PIC	High PIC
Wind and waves	Adopted freeboard for embankment dams should be the largest of the following three freeboard requirements:			
	Freeboard at Maximum Normal Reservoir Level	Wind set up and wave run up for the highest 10% of waves caused by a sustained wind speed, which is dependent on the fetch, with an AEP(1) of greater than 1 in 100.		
	Freeboard at Intermediate Flood Levels	Freeboard should be determined so that it has a remote probability of being exceeded by any combination of wind generated waves, wind set up and reservoir level occurring simultaneously.		
	Freeboard at Maximum Reservoir Level during the Inflow Design Flood (IDF)	The greater of (a) 0.9m or (b) the sum of the wind set up and wave run up for the highest 10% of waves caused by a sustained wind speed, which is dependent on the fetch, with an AEP(1) of 1 in 10.		
Flood event	Inflow Design Flood (IDF)	1 : 100 - 1 : 1,000 AEP	1 : 1,000 - 1 : 10,000 AEP	1 : 10,000 AEP - PMF
Earthquake	OBE – Operating basis earthquake	1 : 150 AEP		
	SEE – Safety evaluation earthquake	50th percentile level for the CME(4) if developed by a deterministic approach, and if developed by a probabilistic approach then at least a 1 : 500 AEP ground motion but need not exceed the 1 : 1,000 AEP ground motion.	50th to the 84th percentile level for the CME if developed by a deterministic approach, and need not exceed the 1 : 2,500 AEP ground motion developed by a probabilistic approach.	84th percentile level for the CME if developed by a deterministic approach, and need not exceed the 1 : 10,000 AEP ground motion developed by a probabilistic approach.

1. Maximum Normal Reservoir Level (FSL) plus - Wind set up and wave run up for the highest 10% of waves caused by a sustained wind speed, which is dependent on the fetch, with an AEP greater of 1 : 100.
2. Intermediate Flood Levels – Taken to be maximum reservoir level during the inflow design flood (IDF) plus the wind set up and wave run up for the highest 10% of waves caused by a sustained wind speed with an AEP of 1 : 10,00.
3. For the Maximum Reservoir level during the Inflow Design Flood (IDF) plus the greater of:
    a. The maximum flood water level plus 900 mm.
    b. The sum of the wind set up and waste run up for the highest 10% of waves caused by sustained wind speed with an AEP of 1 :10.

The assessment against these criteria indicates each is met with the crest level of 132.0 m RL (Table 43).

Table 43: Freeboard Criteria and Summary

	Freeboard criterion			
	1=FSL+waves (1:100)	**2=FSL+IDF+ waves (1:100)**	**3a=FSL+IDF+ other allowance**	**3b=FSL+IDF +waves (1:10)**
Crest level	**132 m RL**	**132 m RL**	**132 m RL**	**132 m RL**
Criterion (NZDSG)	**Criteria is met**	**Criteria is met**	**Criteria is met**	**Criteria is met**
		=		
Other allowance	-	-	131.982 m RL	-
		+		
Wave runup	131.337 m RL	131.519 m RL	(900 mm)	131.442 m RL
Wind setup	130.907 m RL	131.089 m RL		131.087 m RL
		+		
IDF rise	-	131.082 m RL	131.082 m RL	131.082 m RL
Antecedent rise	-	130.956 m RL	130.956 m RL	130.956 m RL
		+		
FSL	**130.9 m RL**	**130.9 m RL**	**130.9 m RL**	**130.9 m RL**

Antecedent rise over spillway is approximately 56 mm.
Flood rise with antecedent flow 182 mm
Wind set up for 1:10 AEP wind is approximately 5 mm.
Wave runup for 1 : 10 AEP wind is approximately 355 mm < 300 mm adopt 355 mm.
Wind set up for 1:100 AEP wind is approximately 7 mm.
Wave runup for 1 : 100 AEP wind is approximately 430 mm < 300 mm adopt 430 mm.

11.9 Summary

The flood flows are used in the assessment of spillway requirements and freeboard (Figure 26). The estimation of flood flows accounts for:

- The design criterion of 1 : 10,000 ARI 0.01 % AEP for a Medium PIC dam.
- Local rainfall conditions through HIRDS Version 4.
- Climate change in accordance with MoE (2018).
- Inflow to the reservoir, attenuation, and discharge from the reservoir.

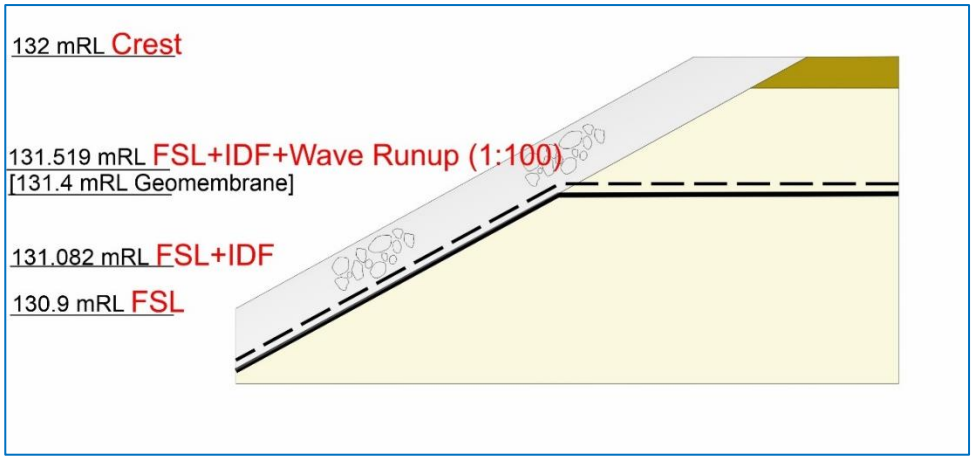


Figure 26: Freeboard Arrangements

The spillway discharge characteristic provides considerable redundancy in the design (Figure 25). The design discharge is only a small proportion of the total capacity of the weir on the spillway crest. If the water level reaches the elevation of the top of the low permeability geomembrane on upstream face of the dam, the watertight elevation, the weir could discharge greater than 10 times the maximum design flow. This excess capacity caters for the possible variations in the understanding of the hydrology of the catchment.

The central section of the crest weir can be engineered to provide a weak structural element that can be demolished with hand tools to provide additional discharge to lower the top water level should this be desired in an emergency following an earthquake.

The design of the spillway provides:

- Redundancy in hydraulic performance, to cover variations in hydrology.
- Safety in operation by adopting shallow water depths at design flows.
- Optimisation in structural form to minimise the construction requirements and time required for construction.

12.0 Emergency Drawdown

12.1 Introduction

A low-level outlet is an important safety feature in dams. It allows water levels to be lowered in an emergency. Hinks (2009) and Environment Agency (2017) provides guidance for the target capacity of the outlet facility, for dams worldwide. For many purposes it is important to assess how far a reservoir can be lowered below top water level in say 24 hours.

NZDSG (Module 1 Section 4.3) defines the low-level outlet as an appurtenant structure and therefore the low-level outlet must meet the performance requirements associated with the Potential Impact Category of the dam.

In addition, NZDSG (Module 3 Section 6.5.5 pp 50, Section 6.11.6 and pp 91) indicate the design of low-level conduits should consider various measures and incorporate factors, some of which are:

- Non-pressurised flow conditions.
- Upstream bulkhead facilities, to isolate the conduit from the upstream reservoir, and be of a sufficient size to enable inspection and the completion of any necessary repairs.
- Upstream valve to enable maintenance and replacement of the outlet valve.
- Facilities for detection and monitoring of any conduit leakage.
- Continuous support on concrete bedding extending at least to the spring line (NZDSG Module 3 pp 50).

However, NZDSG (Module 3 pp 50) also states that where recommended practices are not followed, a risk assessment may assist in establishing whether a potential deficiency needs to be addressed. The adopted arrangement considers the risks of long-term integrity of the pipe, the consequences of pipe failure, internal erosion of the embankment fill, integrity of the systems in extreme earthquake motions, the ability to monitor the performance of the low-level outlet and health and safety considerations, particularly the requirements for man access.

Man access along conduits are often provided for large outlets to large dams. However, these man access conduits introduce significant detrimental features:

- Man access into a restricted space requires particular considerations for safety and the extraction of injured persons should this occur.
- Man access conduits are typically large concrete structures which are more susceptible to settlement and damage in earthquakes than small flexible pipes. Considerable additional measures are necessary to protect against soil erosion in the surrounding embankment fill.

For these reasons the approach is to adopt:

- 4 high integrity, HDPE flexible pipes, which can accommodate extreme earthquake motions, and possible nominal settlement over the in-situ gravels.
    - All 4 act as outlet pipes for water delivery to the water treatment plant.
    - 2 of the 4 are intended as dual-purpose pipes for emergency drawdown.

- additional measures to protect the embankment against high pressure water in the outlet pipes formed over the foundation. These are:
    - A concrete surround to the pipes in the zone below the embankment's upstream shoulder.
    - A high-capacity drainage system surrounding the pipes as they pass below the embankment's downstream shoulder.
- Leak detection systems where the pipes emerge from the downstream toe of the embankment.

12.2 Upstream bulkhead

The upstream bulkhead is provided by the valves and the concrete draw off structure on the upstream pace of the embankment.

The outlet pipes are anchored into the bulkhead to prevent thermal or other movements of the HPDE pipe from compromising the seals with the geomembrane liner system on the internal face of the reservoir.

12.3 Main outlet pipes and surround

The main outlet pipes are smooth wall continuously welded HDPE pipes capable of sustaining the normal working pressures and over pressures in the system. Being of flexible HDPE the pipes provide:

- Considerable resilience to earthquake motions and foundation settlement, which is likely to be limited in the stiff terrace gravels.
- Sufficiently strong to resist the overburdened pressures of the embankment above.

Nonetheless, the upstream shoulder of the embankment is vulnerable should there be a pipe breach and high-pressure water enter the embankment fill. To mitigate this risk the HDPE pipes are surrounded by a concrete encasement capable of withstanding the hydraulic pressures and the overburden pressures. This reinforced concrete encasement:

- Has external side slopes of 8 vertical:1 horizonal to assist in providing good contact and compaction of the surrounding embankment fill.
- Loads are assessed using the methods developed by USBR (USBR, 1968). Where there are potential beneficial effects of external pressures when assessing possible tension in the concrete encasement these are ignored. Although the methods are not an exact representation of the circumstances the conditions are sufficiently representative for the current purposes.

12.4 Filter collar and Chimney Drain Interface

A large high-capacity filter collar embedded within the lower part of the chimney drain provides a secure means of transitioning from the upstream encasement to the downstream drainage measures. The proportions of this filter collar are determined in accordance with the arrangements provided by Fell, Figure 13.16 (2015). This filer collar comprises:

- Drainage material, which is contiguous with the drainage material surrounding the pipes downstream of the centreline.
- A filter transition between the drainage material and the general embankment fill to provide filter compatibility across the zones.

The stiff underlying terrace gravels are unlikely to exhibit significant settlement. However, there is a disparity in behaviour between the ridged concrete pipe surround below the upstream shoulder and the flexible and accommodating behaviour of the pipe and formation below the downstream shoulder. In the detailed design a short transition slab will be included below the pipe to prevent significant shear at the interface.

12.5 Downstream drainage media and seepage control

Downstream of the centreline and chimney drain potential pore pressures in the downstream shoulders are low. Therefore, should there be a fracture in one of the high integrity HDPE pipes, potential seepage carrying embankment fill into an empty pipe is very low. However, the embankment fill still requires protection against the low possibility of a pipe failure and the potential for water to water escaping a pipe into the surrounding fill.

The pipes, both the low-level outlet pipes and the drainage pipes in the surrounding drainage materials are designed to meet the performance criteria for (AS/NZS 5266.1:1998 Buried Flexible pipelines Part 1 Structural design):

- Long-term internal pressure.
- Long-term bending strain.
- Buckling pressure.
- Also, for the perforated drainage pipes, allowance for the perforations is made by the reduction of pipe strength in accordance with FEMA (2007).

Typically, a failed HDPE pipes does not fully collapse and as a result some flow is carried through the remaining cross section. Therefore, only a portion of the flow is likely to escape the pipe. Nonetheless, to provide a resilient response to the possible failure, or partial failure of a pipe, the surrounding drainage system is assumed to carry the full discharge of a single failed pipe.

The flow capacity of the drainage arrangement surrounding the low-level outlet pipes is a combination of (Figure 27):

- Flow in the drainage material. Given the high-pressure flow entering the granular drainage materials the flow is likely to be turbulent (Li, Garga, & Davies, 1998) rather than laminar. This approach yields the lower of the two flow capacities for the same drainage materials.
- Flow in the drainage pipes, and the capacity of the perforations to accept the flow in the surrounding materials.

NZDSG (Module 3 pp 50) suggests that drainage pipes should be double wall, corrugated with a smooth bore. However smaller, thick wall HDPE pipes are preferred because of the likely increased resilience to earthquake motions.

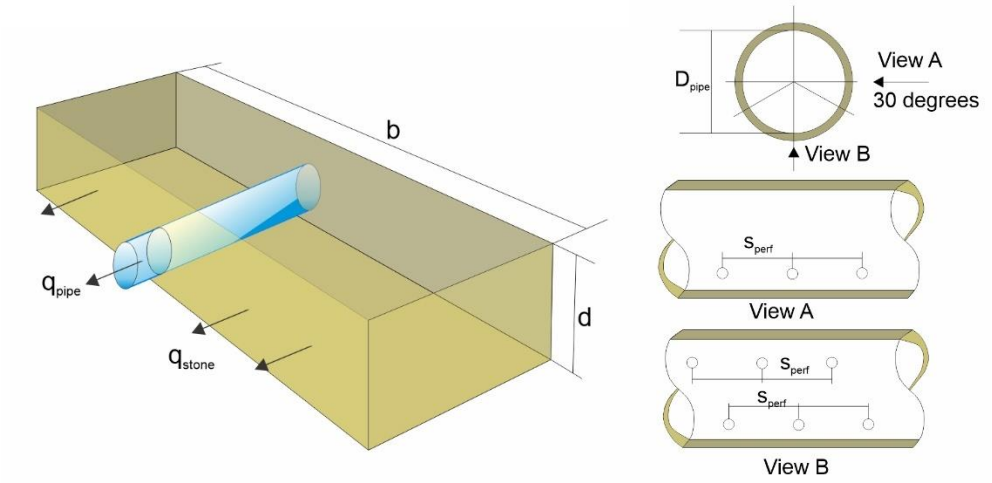


Figure 27: Drainage System Capacity and Drainage Pipes Arrangements.

12.6 Downstream thrust block and valve arrangements

The low-level outlet pipes exit the downstream shoulder at a substantial thrust block. The thrust block provides a stable platform for:

- Thrust rings in the head wall to restrain the outlet pipes against hydraulic or thermal stresses.
- Isolation valves.
- Pipe junctions on two pipes for flow distribution.
- Values on the emergency draw down discharge pipelines.

The flow from the drainage pipes and drainage media are collected behind the head wall and discharged to one side of the head wall for measurement in a weir box. Regular measurement of this weir box allows reservoir operators to identify whether there are changes in the outlet pipes remain in working order.

The thrust block is an appurtenant structure (NZDSG, Module 1 Section 4.3, Module 3 Section 6.11). The integrity of the block is necessary for the correct functioning of the reservoir therefore its arrangement is intended to meet the stability requirements for a SEE earthquake (NZDSG Module 3 Section 4.3.3).

12.7 Energy dissipation and discharge

The low-level outlet pipes discharge to the lower end of the left bank of the spillway chute. The spillway chute at this location is a grass channel, therefore residual hydraulic energy must be dissipated before entering the channel, where otherwise it would cause erosion and damage to the chute.

There are several structures that might achieve necessary energy dissipation, such as a:

- USBR Type VI impact basin. This type of energy dissipator is a compact means of dissipating energy from a horizontal pipe discharge.
- USBR vertical stilling well. A vertical stilling well has a small footprint, and dissipates energy in a vertical chamber, which discharges quiescent flow near the surface.

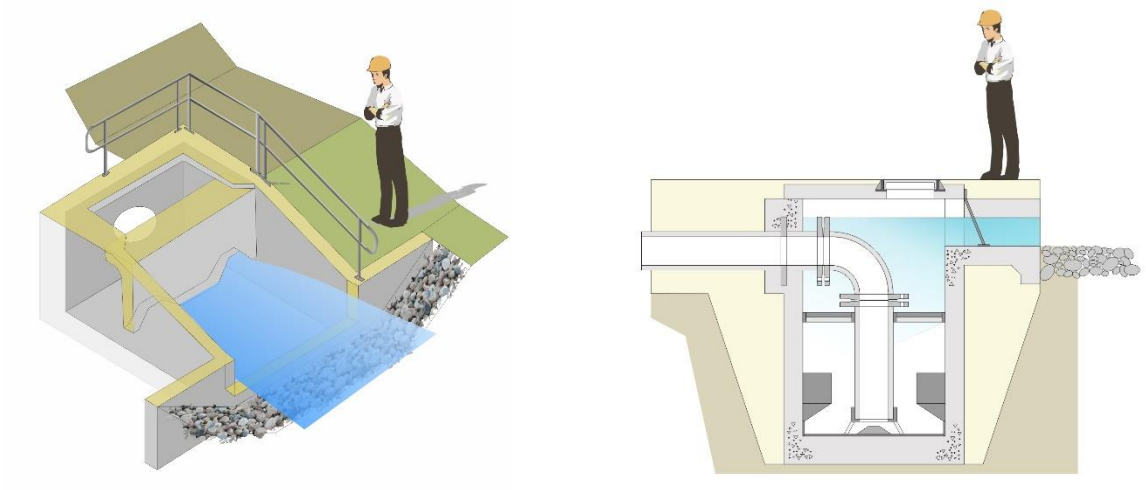


Figure 28: Energy Dissipation – Type VI impact basin (L) Vertical Stilling Well (R)

For the purposes of the feasibility design each of the low-level outlet pipes discharge to vertical stilling wells, which discharge into the left bank of the spillway chute. Specific details for these stilling wells include:

- A small drain at the invert of the stilling well which discharges directly to the left bank of the Ōhau River. This allows the well to drain after use, so that in normal operation the chamber is empty.
- The top assess manhole has a lockable cover to prevent unauthorised access.
- The discharge exit is a narrow slot to allow the discharge to the spillway, this is covered by a sloping bar screen to prevent unauthorised entry and prevent large windblown detritus from collecting in the chamber.

Notwithstanding the measures included in the arrangements to reduce maintenance and increase safety, some maintenance and clearance of debris from the stilling wells will be necessary. Also, any location where there is high energy flow incorporates inherent safety issues which must be adequately isolated with handrails and identified at the outlet structures.

13.0 Draw Off and Delivery to Water Treatment Plant

13.1 Introduction

The ability to draw water from the reservoir for delivery to the water treatment plant is a primary function and objective for the facility. Conveying the water to the water treatment plant incorporates the following components:

- Draw off arrangements at different levels through the water column.
- Draw off pipes across the foundation level of the embankment to the downstream toe of the embankment.
- A pumping station to provide the hydraulic head for the water to be conveyed to the treatment plant.
- A rising main to convey the water from the reservoir to the treatment plant.
- An unobstructed, uncontrolled catchpit at the treatment plant for the reception of flow and entrance to the treatment plant.

This feasibility study does not cover any works that might be required in the existing water treatment plant to manage and treat flows from the reservoir that might have a different water quality from the current flows taken directly from the Ōhau river.

13.2 Draw-off Arrangements

The draw-off is intended to be sufficiently resilient to supply water after an earthquake. For this reason, the draw-off arrangements require careful consideration of their performance and behaviour in a severe earthquake.

Often draw off arrangements are either:

- A vertical tower embedded at the toe of the upstream shoulder of the embankment.
- A vertical tower at a location away from the embankment altogether.
- A vertical shaft buried within the embankment near the centre line of the embankment.

Any vertical tower arrangement is susceptible to the severe earthquake motions and forces, consequently the proposed arrangement is set at grade on the inside face of the embankment. This arrangement is intended to allow the draw-off to move in unison with the embankment.

13.3 Pump Station Arrangements

The four low level outlet pipes, exiting the embankment toe on the thrust block are connected to a manifold in the pumping station. This manifold distributes the reservoir water evenly to each of the station’s pumps.

The pump station has the following characteristics (Figure 29):

- The base level of the station is set at or slightly above the flood level in the Ōhau River.
- Perimeter walls to reduce the possibility of flooding in extreme events.
- 4 duty pumps.
- 1 standby pump.

- 2 rising mains, two duty pumps discharge to each rising main.
- Steel superstructure to support steel cladding and craneage if and where necessary.

In common with many pump stations, the pump size does not determine the physical size of the station. Rather, the size is governed by:

- Pipe arrangements on the suction and delivery side of the pumps.
- Pipe drain down, pump isolation, and maintenance access to each pump.
- Sufficient separation between pumps to allow for safe maintenance of a pump without shutting down a neighbouring pump.
- Access into the station for extraction and replacement of pumps as well as other items.
- Areas for control panels and power supply.

Notwithstanding these constraints on the dimensions of the station, the plan area is optimised by orientating the discharge pipes vertically from each pump and then connecting these to the rising mains above the inlet manifold. Although this arrangement optimises the station's plan area, it does require support for the raised pipe work and sufficient clearance for installation and removal of overhead pipe work.

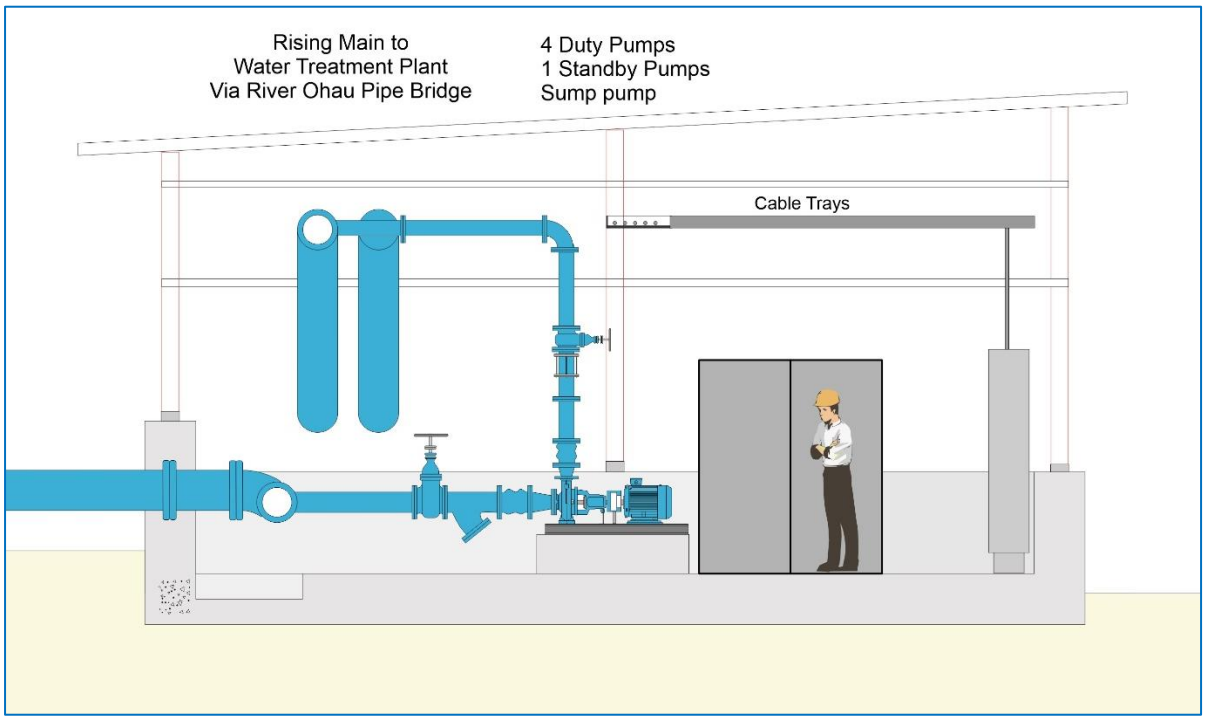


Figure 29: Pump Station Cross Section

13.4 Rising Main to Water Treatment Plant

The rising main to the treatment plant adopts two flexible and durable HDPE pipes. Although other materials have been adopted for rising mains smooth wall HDPE pipes have the following advantages for this rising main:

- HDPE material is appropriate for carrying raw water mains because of its durability and non-corrosive qualities.

- The flexibility of the pipe reduces potential water pressure transients at pump start up and shut down.
- The inherent durability and flexibility make the pipeline to the water treatment plant resilient in earthquakes.

The pipeline is intended to pump along a continuous twin rising main from the pumpstation to the water treatment plant, and discharge as free discharge to a chamber at the entrance to the water treatment plant. This free discharge condition is a fundamental aspect of the rising main design. If the discharge is altered to a valve that can close, then excessive pressure transients could occur against the valve and along the pipeline that would require different approach to the pipeline design.

The actual discharge duty for the rising mains is dependent on:

- The choice of pump and its discharge characteristics.
- The length of pipeline and its materials.
- The diameter of the pipe, which is taken as 267 mm Internal Diameter.
- The various pipe fittings that are incorporated along the pipeline.
- The maximum and minimum water levels in the reservoir.
- The elevation of the discharge point in the chamber at the water treatment plant.

The intersection of the twin pump and rising main characteristic provides the duty points for the operation of the rising main (Figure 29), two of these systems provides the potential total discharge from the reservoir to the reservoir to the treatment works. The assessment demonstrates:

- The elevation of the treatment plant is lower than the reservoir water level. Therefore, the static head at the pump is negative and this reduces the duty head on the pumps.
- The pipeline friction over the pipe length and fitting losses dominate the duty requirements for the pumps.
- The potential discharge when the reservoir is at Full Supply Level (FSL) is higher than when the reservoir is drawn down, but at both water elevations and given the pump characteristic adopted, the minimum discharge requirement of 108 l/s per rising main is achieved.
    - Water level at FSL 119 l/s duty discharge.
    - Water level at reservoir base 111.8 l/s duty discharge.
- The velocity within the rising main is between 2.14 m/s and 2.00 m/s, which is within the normal operating range for HDPE pipe. High velocities rapidly increase the dynamic head and thereby increase the annual operating costs. Lower flow velocities can promote solids in the flow to settle in the pipe and require more frequent cleaning.
- The duty points on the pump curves are on the descending leg of the curve indicating the pump adopted for feasibility design is operating is a low efficiency zone. Detailed design should optimise the choice of pump to increase the efficiency and reduce the power requirement.

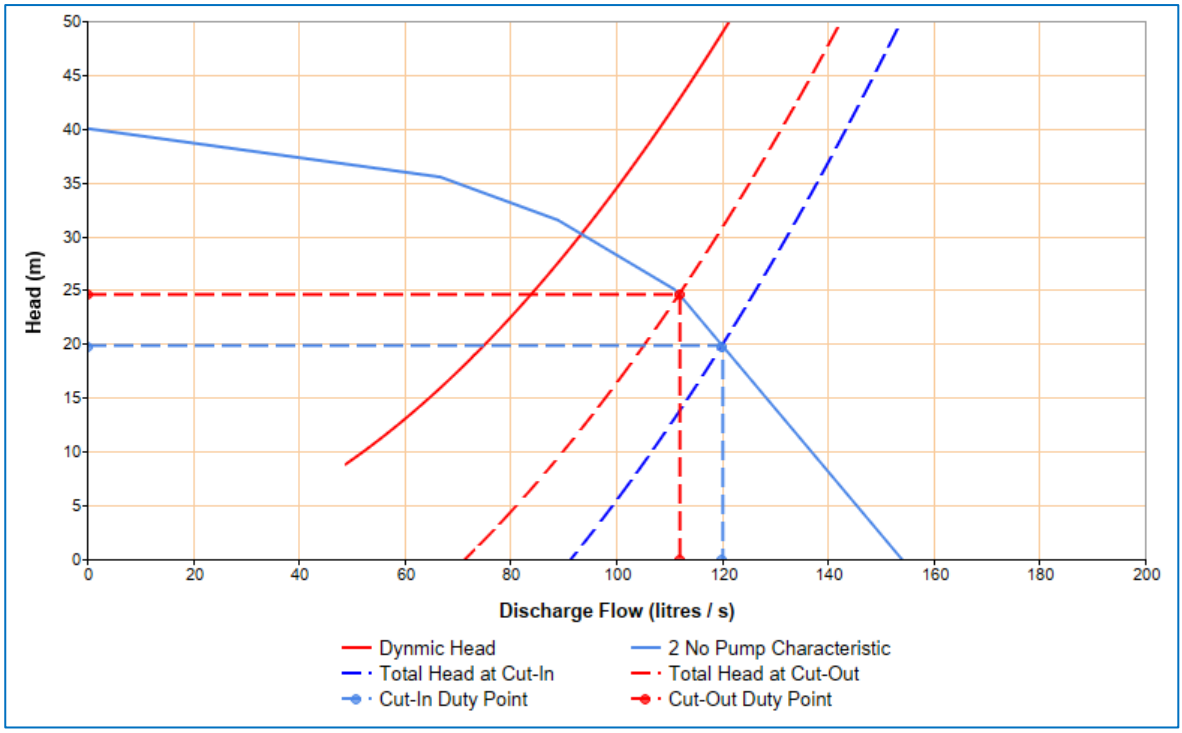


Figure 30: Pump and Rising Main Discharge Characteristic

An initial assessment of pressure transients occurring at pump start up and shut down indicate no specific over pressure suppression is necessary. However, in common with many raw water mains that follow undulating terrain, air inlet valves will be required as high points along the route to the treatment plant and regular inspection pits are required to allow for cleaning of the pipes.

The trench design adopts the AS/NZS 5266.1 approach to the design of buried pipes in both the verge beside a road alignment and along a road. This defines:

- The depth of burial as a minimum is 600mm to the crown of the pipe.
- The wall thickness of the pipe.

The advantages of burring the pipe are:

- The temperature of the HDPE remains relatively constant throughout the year. Thus, the pipe does not expand and contract significantly along its length.
- The pipe is unlikely to be damaged accidentally.
- The pipe does not consume areas of the narrow Gladstone Road corridor.

The temperature variations of the air, seasonally and diurnally, induce significant expansion and contraction of the pipe where it is the ground surface. Therefore, specific measures to allow for this expansion are required at either end of the pipe bridge. These measures will be developed at the detailed design stage.

14.0 Dam Monitoring

14.1 Introduction

Surveillance instrumentation will be finalised as part of detailed design but is likely to consist of:

- Standpipe piezometers located on the crest of the embankment.
- Survey marks; located on the crest of the embankment.
- Reservoir water level sensor.
- Reservoir water level staff gauge.
- Seepage monitoring, for the embankment toe drainage
- Seepage monitoring for the drainage system surrounding the low-level outlet.

14.2 Survey Markers

Survey markers will be provided on the downstream side of the crest. They are spaced at intervals, with one at the cross section of maximum fill height. Consequently, the measurements at these locations can be used to assess the progression of settlement within the embankment and compare these measurements predicted in the design.

Settlement is likely to be a combination of consolidation in the foundations and settlement within the embankment. The effect of interest is the combined effect on the settlement of the embankment crest. Consequently, it is not necessary to differentiate between the two components. Measurement of gross settlement can be achieved by surface settlement plates. The location and design of surface settlement plates are influenced by:

- A secure foundation to the plate so it will not move or rotate in the near surface environment.
- Not damaging the HDPE runout under the upstream half of the crest; place the markers along the outside margin of the crest.
- Not impacted by vehicle traffic on the embankment crest.

In addition to the settlement markers, two base stations should be established on ground that is unlikely to move. These provide survey control for measurements.

14.3 Seepage Monitoring

The purpose of monitoring these drains is to identify the circumstances under which they discharge significant flows, particularly if the water is discoloured. Such circumstances may indicate changes occurring within the reservoir and, or the embankment.

The seepage flow monitoring is provided by v shaped weir boxes at the end of drainage systems. These are monitored periodically as part of a normal surveillance route march. Weir boxes are provided for:

- The two groundwater pipe drains that daylight from the toe of the embankment.

- The collection drains discharging from the blanket drain at the toe of the embankment. The seepage assessment suggests that under normal circumstances there should be little if any seepage discharge from these drains.
- The discharge from the drainage system surrounding the low-level outlet pipes.

14.4 Water Level Monitoring

Water level monitoring in the reservoir should be provided by two means:

- A staff mounted on the draw off outlet slab.
- An automatic water level gauge also mounted on the draw off slab.

14.5 Standpipe Piezometers

Standpipe piezometers are to be provided at various location around the reservoir to identify changing pore pressures in the downstream shoulder. At each location there are two piezometers, one above the toe drain and the other below. Monitoring the pore pressure at these two levels permits the identification of changes as they might occur in the downstream embankment shoulder or the foundation.

Future development can include retrofitting standpipes with downhole loggers and automated wireless transponders to relay information to a SCADA system.

15.0 Infrastructure

15.1 Introduction

Apart from the primary components required for the scheme, such as the river intake, embankment, pumping station and the rising main, other items required to support the functioning of the scheme.

These items are not fully detailed in the feasibility design but are outlined below as a basis for assigning a cost estimate to each.

15.2 Power Supply

The pumping station at the reservoir will require an electrical power supply for the pumps and ancillary equipment. This power supply will be an extension of a three-phase supply. The possible location for the nearest three phase supply and the potential spare capacity for the current has not been investigated. However, an extension of a three-phase supply will probably require at least:

- A connection to the grid.
- A power line along across the Ōhau River and along Poads Road.
- A transformer and switchgear at the reservoir.

15.3 Backup Power Supply and Housing

Given the significance of the reservoir in supporting a post disaster response for the area, the reservoir should be provided with an independent backup power supply. Options might be considered for disaster response:

- Typically, an onsite diesel generator is installed for backup power. However, these generators require diesel tank on site as well as regular maintenance and testing.
- A mobile diesel generator could be held at the water treatment plant and towed to the reservoir when necessary.
- Alternatively, there could be a fleet of water bowsers that fill directly from the reservoir, probably from a valve fitted to the low level outlets on the thrust block. This approach would not overcome the requirements for treating the water prior to distribution or crossing the Ōhau River if the bridge is compromised, by flood or earthquake.

These options can be investigated at detailed design.

15.4 Pipe Bridge

The Pipe Bridge crosses the Ōhau River immediately upstream of the Poads Road Bridge. It is approximately 3.5 km upstream from the existing water treatment plant at the road junction with Gladstone Road. Here a pipe bridge must carry the two rising mains over the Ōhau River, approximately at the same location of the previous, but now demolished, pipe bridge.

To provide resilience for the water supply following an earthquake on the Northern Ōhāriu Fault, the pipe bridge should span the river and fault at this location. Although the exact location of the fault at this location remains uncertainty, the bridge span is expected to be approximately 80 m to straddle the river and fault (Figure 31).

The fault is a right lateral strike slip fault. This suggests fault movement is expected to be along the line of the fault with little vertical displacement.

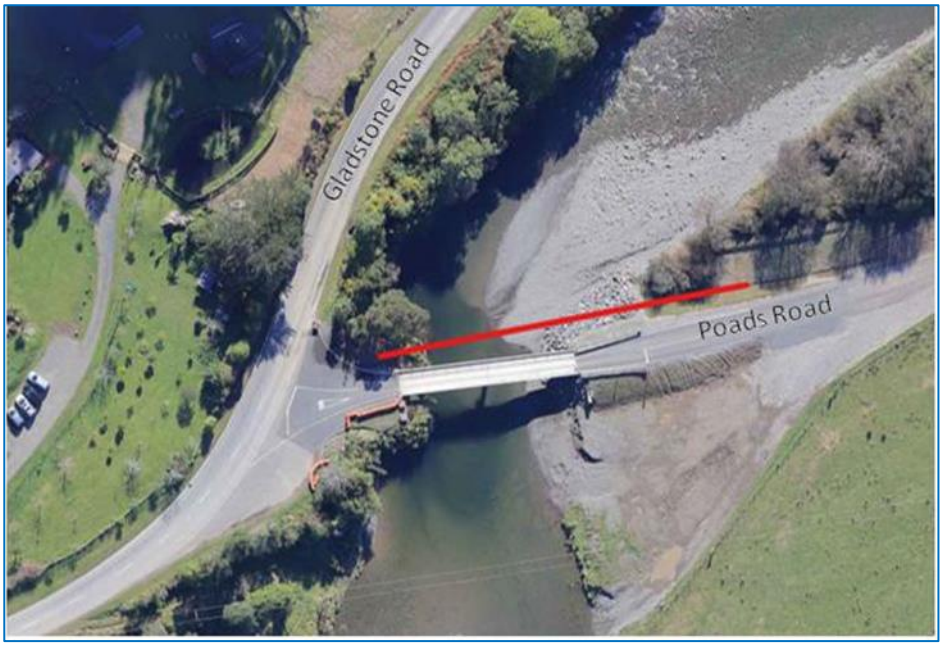


Figure 31: Proposed Location of Pipe Bridge

Each abutment is reinforced concrete and supported on reinforced concrete piles.

- On the left bank, the eastern abutment, the pile cap is oversized to allow for the expected large movements of significant earthquake. This pile cap allows for movement both longitudinally and transversally.
- On the right bank, the western abutment, incorporates articulation to allow the bridge to rotate in a large earthquake. This rotation allowance allows for lateral movement and limited vertical movement.

Options for the span are formed of fabricated steel and include a steel truss or a lighter steel arch structure (Figure 32). The options for the bridge span must:

- Maintain a freeboard beneath the bridge of 0.6m at a 1: 1000 year ARI (0.1% AEP) flood event in the Ōhau River.
- The bridge should not collapse in a 1: 10,000 year ARI (0.01% AEP) earthquake.
- Provide a span sufficient to eliminate piers in the waterway.
- Provide for assembly of the span outside the river course.
- Incorporate safety barriers along both sides of the structure to allow pedestrian maintenance access.

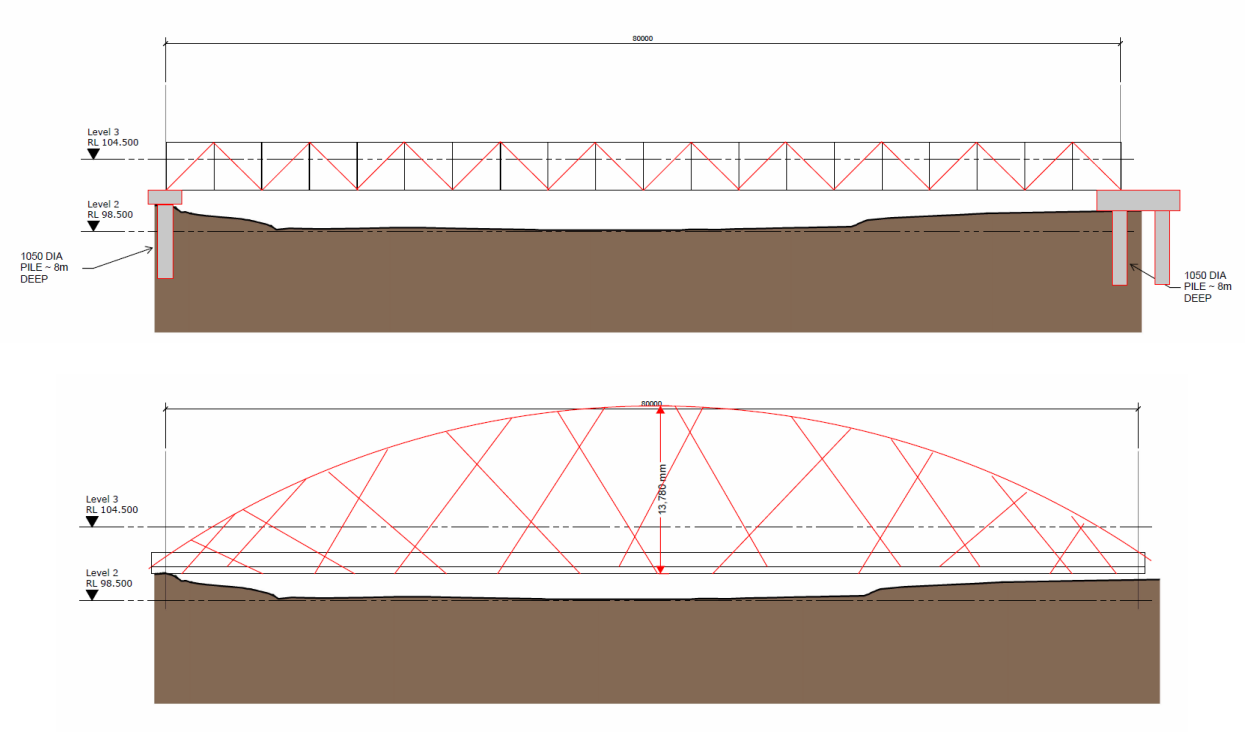


Figure 32: Pipe Bridge Span Options

15.5 Roads

The following roads are required to support the scheme:

- A diversion and realignment of Poads Road to maintain access to the building and car park at the southern eastern end of the road.
- An access road is required from Poads Road to the various facilities, including the pumping station at the toe of the embankment. This provides access for operation and maintenance as well as providing an additional protection to the embankment toe, where it is lowest, from river floods in the Ōhau.

15.6 Reservoir Water Quality

Shallow reservoirs that store water for extended periods can suffer progressive decreases in dissolved oxygen and stagnation of water in the lower profile of the reservoir. Given the projected increasing water demand and the potential intake rates from the Ōhau river, there is a low potential for a degradation on the water quality over time.

However, the reservoir is relatively shallow and water quality degradation can occur rapidly in raised summer temperatures. For this reason, the reservoir should be provided with an air bubbler to maintain the water quality. A water bubbler consists of an air compressor and a pipe delivering the compressed air to the lower reservoir profile to oxygenate the profile and to promote water circulation. The bubbler pipe can be affixed to the draw off slab.

15.7 Boat Ramp

The perimeter of the reservoir can be inspected primarily from the perimeter track. However, there may be circumstance when the water level is partially drawn down where inspection from the water level could be advantageous. For this reason, the feasibility design includes a boat ramp for launching a small craft for inspection.

The boat ramp can be constructed over the top of the geomembrane so that the integrity of the geomembrane is not compromised.

The general arrangement of the boat ramp is developed from the details provided by Queensland (Department of transport and Main Roads) (2015).

15.8 Fencing

Any open water body along with machinery and electrical introduce risks that were not presented previously. Therefore, there should be the following fencing arrangements:

- **Site boundary:** A 2m high general fencing to delineate the site boundary to deter unauthorised entry.
- **Main facilities:** Buildings of particular significance should be provided with adequate security. Where this is not provided by a locked building the zone should be surrounded by palisade fencing, such as the power transformer.

16.0 Operation, Maintenance and Surveillance

16.1 Introduction

The proposed reservoir will have a Dam Safety Management System to provide safe operation in accordance with NZDSG and appropriate to a Medium PIC dam.

The Dam Safety Management System will include operations, maintenance, surveillance and emergency action plans and procedures that include:

- Dam safety-related management and reporting responsibilities.
- Identifying and managing dam safety issues.
- Information management.
- Audits and review.

The following sub-sections outline some of these procedures that will be prepared prior to commissioning.

16.2 Dam & Reservoir Operation

Normal operation of the reservoir will be managed by Horowhenua District Council with assistance from an automated control system.

Automated systems operated by Horowhenua District Council, probably at the Levin Water treatment Plant, will control and monitor:

- Flows from the river intake to the reservoir.
- Flows from the reservoir, thorough the pumping station to water treatment plant.

The control system will manage filling and emptying of the reservoir to prevent overfilling. Alarms will be conveyed to the manager and operators to indicate problems requiring quick resolution, as sensor failure or overfilling of the above full supply level.

The control system will include a manual operation mode to enable on the spot management of the reservoir under emergency or unusual conditions to allow an operator (or manager) to control the operation on-site. Note that the spillway is the secondary control measure to prevent overtopping of the reservoir embankments.

16.3 Maintenance

Maintenance activities will primarily be:

- Maintenance of the pumps and supporting infrastructure.
- Control of vegetation on the outer embankment slopes and repair of any erosion by runoff from intense rainfall.
- Maintenance and testing of the control system and control valves.
- The reservoir water level sensors will have regular functional and calibration checks.
- The piezometers will also require periodic response testing.

The HDPE liner is robust and is in addition protected across the reservoir base and over the exposed zone near the embankment crest by granular riprap. Therefore, damage to the liner is not expected to be a common occurrence. Should there be liner damage it is likely to become apparent by monitoring increased flows in the embankment's toe drain. However, in addition, the reservoir should be drawn down periodically to inspect the liner and outlet works. The HDPE lining will be repaired if any puncturing or tearing is identified during inspections.

16.4 Surveillance

Surveillance consists of periodic inspection and monitoring of the embankment, inlet and outlet locations, liner system condition and the spillway. Operators involved in surveillance typically receive training in surveillance procedures and the appropriate potential failure modes. Results of the surveillance:

- Build an accurate history of dam safety observations both visual and instrumented.
- Allow the performance of the dam to be regularly assessed and reported.
- Enable the early detection and mitigation of potential deficiencies or adverse trends.
- Fulfil legislative and regulatory requirements.

Instrument readings and visual inspection observations are recorded on prepared forms by the operators and reported to the manager, who manages the performance assessment of the reservoir's embankment and appurtenant structures performance. A monthly surveillance report is prepared assessing the performance, alarm conditions and intervention actions taken.

Surveillance instrumentation is typically finalised in detailed design, but is likely to consist of:

- Standpipe piezometers located on the crest of the embankment.
- Weir flows.
- Survey marks; located on the crest of the embankment.
- Reservoir water level sensor.
- Reservoir water level staff gauge.

Surveillance alarms are set to alert the manager to the need for investigation and action to maintain dam safety.

Special inspections are undertaken at least annually when the water level in the reservoir is low. These inspections focus on the condition of the lining. Inspection check lists take account of the potential failure modes and will include visual inspection for the liner's condition and seepage both through the embankment and adjacent to the offtake structure.

Intermediate inspections are undertaken yearly by an engineer suitably experienced in dam safety. The purpose of the intermediate inspection is to confirm satisfactory behaviour of the dam and identify dam safety issues through visual examination and review of surveillance data. These inspections aimed to confirm the safety of the dam and would include, but are not limited to:

- Review of the previous monthly and annual inspection and surveillance records.
- A visual check of the embankment and appurtenant structures as detailed under the monthly routine inspections.

- Discussion with the reservoir manager on the operation, maintenance and surveillance of the dam and any matters of potential significance.
- Preparation of a report detailing:
    - Performance and condition of the dam and associated structures.
    - Recommendations on any aspect related to dam safety and any additional inspections prior to the next planned inspection.

A Comprehensive Dam Safety Review (CDSR) will be undertaken every five years by an engineer suitably experienced in dam Comprehensive Dam Safety Review. The CDSR purpose is to confirm satisfactory behaviour of the dam, identification of deficiencies by a thorough onsite inspection; evaluation of data and applying current dam engineering best practice and understanding of the dam embankment and foundation. The CDSR will include, but are not limited to:

- A review of previous inspections and surveillance reports.
- A thorough visual inspection of the pond and associated structures.
- A review of the piezometer data.
- A review of results from deformation survey of the survey marks located on the embankment crest.
- Inspection and witness of equipment operation such as control gate(s) to identify any deficiencies.
- An assessment of the performance of the dam and it's dam safety-related equipment.
- Review of the potential impact classification (PIC).
- Review of progress in addressing previous dam safety-related recommendations and issues.
- Review of the dam safety management system and identification of necessary changes.
- Assessment of the reservoir safety with respect to current acceptability criteria.
- Identification and discussion of dam safety issues identified during the CDSR.
- Discussion with the manager of the dam operation, maintenance and surveillance and any matters of potential significance.
- Preparation of a report documenting the CDSR.

16.5 Surveillance Post Earthquake and Extreme Rainfall

Additional inspections and monitoring will be undertaken following extreme rainfall and after earthquakes of felt intensity MM 6 or greater at the site. Surveillance and post-earthquake procedures are important components in the dam safety programme. If the HDPE liner is compromised, the embankments internal arrangements provide sufficient time to consider response actions for lowering reservoir levels and make repairs.

16.6 Emergency Planning

An emergency action plan will be developed in accordance with the NZDSG prior to commissioning. The objective of the Emergency Action Plan is to minimise the potential for dam failure through pre-planned or pre-conceived intervention actions should a dam safety emergency event arise and, if a dam failure cannot be prevented, to limit the effects of a dam failure on people, property, and the environment.

17.0 Emergency Preparedness

17.1 Introduction

Emergency preparedness provides assurance that appropriate measures are in place to mitigate the effects of any dam safety emergency or dam failure on people, property, and the environment.

The dam is a Medium PIC dam and therefore the dam does require a formal Emergency Preparedness Procedures – Emergency Action Plan (NZSOLD 2015, Module 5 Section 4.5.4 – required for Medium and High PIC). The owner should develop an outline of those actions to be taken if unusual events occur. The typical events, consequences and actions are described below.

The discussion below outlines the approach to the management of the consequences of the following extreme events:

- Flood.
- Seepage.
- Earthquakes.

The threats that are not considered appropriate for this dam (NZDSG Module 6 Section 2.2) are:

- A landslide into the reservoir from the reservoir perimeter because the perimeter slope has a shallow gradient.
- Incorrect operation because the spillway will discharge excess inflow without requirement for operational intervention.
- Accidental damage. The embankment is robust and resilient to damage.
- A volcanic eruption (lava flow, ash, etc). The region is outside areas of immediate volcanic effects.
- Sabotage is very unlikely.

17.2 Flood Events

The design the spillway structure is capable of discharging more than the design flow event. However, more extreme events can occur, and blockage of the spillway can constrain the discharge. If an extreme event occurs and the embankment is over topped the embankments wide crest and shallow downstream slope of low height will allow over topping to occur for a period before the embankment is compromised.

Despite the inherent resilience of the embankment to overtopping the embankment and spillway should be inspected regularly and following an extreme flood event to identify and correct:

- Blockage of the spillway.
- Scour at the downstream end of the spillway apron.
- Damage to the embankment crest and grass cover on the downstream slope.

Any significant dam should be inspected by a suitably qualified engineer.

17.3 Seepage Events

Seepage should be controlled by the geomembrane on the upstream face of the embankment. However, seepage on the downstream face might occur as either rainfall inflation into the crest and downstream slope or due to damage of the geomembrane.

The toe drain may not fully manage seepage emerging from the downstream slope and patches of more vigorous grass may develop as a consequence. The slow development of these patches over a period of years is not necessary a cause for concern given the resilience of the dam arrangements. However, a suitably qualified engineer should be consulted if:

- Seepage flows develop at a specific location and the flow continuous flow increases progressively over a period of hours, days, and week.
- Seepage flows contain soil materials or becomes muddy.
- Seepage flows emerge along the outside face of the spillway structure.
- Seepage flows emerge along the outside face of the farm offtake pipe.

17.4 Seismic Events

Earthquakes are an extreme event and can have unpredictable effects on an earth embankment dam. Earth dams have proven to be highly resilient to damage by seismic shaking. Consistent evidence indicates that good selection of materials and compaction control of the fill in the embankment during construction are significant factors contributing to this observed resilience.

If a seismic event causes obvious structural damage to the embankment that compromises the freeboard the owner should:

- Warn people who might be in the area immediately downstream of the dam that failure might occur.
- Take steps to dewater the reservoir by discharging water through the offtake or using mobile pumps to discharge water over the embankment to the Ōhau River.
- Request an inspection by a suitably qualified engineer.

Following a seismic event, the dam should be inspected by a suitably qualified engineer to assess:

- Damage to the geomembrane.
- Transverse and longitudinal cracking of the embankment, particularly where the embankment alignment changes.
- Damage to the spillway structure.
- Damage to the interface between the farm offtake and the geomembrane on the inside face of the southern embankment.

18.0 Safety in Design

18.1 Introduction

The Health and Safety at Works Act (2015) requires Safety in Design considerations be incorporated into the development of designs. These considerations must cover the full life cycle of the asset. The guidance on the implementation of the Safety in Design is provided by WorkSafe guidance and is based on the Australian Regulations.

Safety in Design (SiD) is the integration of hazard identification and risk assessment methods early in the design process to eliminate or minimise the risks of injury throughout the life of the product being designed.

The concepts are:

1. Safety in Design is about the outcomes (not the process) and the greatest incremental benefits are achieved at the outset of design development.
2. The safety outcomes and project benefits are primarily dependent on the competence, knowledge, and experience of those involved in the process. People (Client, Owners and Designers) who have control over a design must demonstrate or acquire the necessary Safety in Design knowledge and capability.
3. The Principal (the owner of the asset) cannot divest itself of obligations on Health and Safety throughout the life of an asset; this concept includes obligations around Safety in Design.
4. Every individual (i.e., not the body corporate) in the “supply chain” for the development, construction, operation, maintenance and decommissioning of an asset has obligations and liabilities in Health and Safety, and these liabilities are not limited to their part of the supply chain.
5. It is essential to document the outcomes of the Safety in Design process and make sure that this documentation is disseminated and available throughout the life of an asset.
6. There is no single Safety in Design process; a process must be adapted to suit each project.

The benefits of SiD include Barker (2012):

- Better understanding of the design requirements and limitations.
- Prevention of injury and disease.
- Improved usability of structures.
- Improved productivity.
- Reduced costs.
- Better understanding and management of costs over the structure’s lifecycle.
- Compliance with legislation.
- Innovation, in that safe design demands new thinking.

SiD is implemented throughout the development of concept designs by integrating hazard identification and risk assessment methods early in the design process. SiD considers how to eliminate, isolate or minimise the risks of death, injury and ill health to those who will construct, operate, maintain, decommission or demolish the asset.

18.2 Approach

The risk assessment is undertaken in accordance with the internationally recognised ISO 31000 Risk Management standard (ISO, 2018). This assessment approach is adopted because it is well recognised, and:

- Is structured and comprehensive.
- Can be customised to reflect specific circumstances.
- Is inclusive of many facets of a situation.

The methodology adopted in this assessment incorporates the steps of establishing the context, identifying risks, analysing risks, risk evaluation and mitigation as suggested by AS/NZS ISO 31000 (Figure 33).

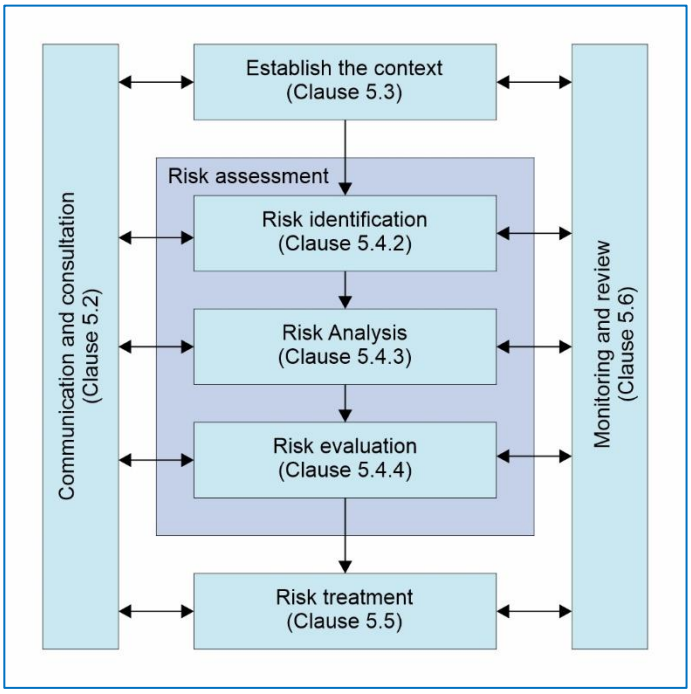


Figure 33: ISO 31000 Risk assessment process

Establish the context for the design:

> Identify foreseeable uses. The designer should identify the client's main objectives and outcomes of the design. This information is important to establish the intended and foreseeable uses of the design.
>
> Complete the Safety in Design Risk Assessment. The following steps are typical for a Safety in Design Risk Assessment, which should be developed and updated regularly during the design stages.

Hazard identification:

> Identify design-related hazards associated with the range of intended uses, including any foreseeable misuse of the product. Hazard identification should not be limited to one or two people's experiences of situations and can include the following:

- Research to help in the identification of hazards and assessment of risks and controls.
- Consultation with all parties involved in the project including where possible contractors familiar with the construction works and fabricators/suppliers of the equipment being proposed.
- Guidance material including codes of practice, technical standards, or industry protocols.
- Hazard identification and risk assessment tools. The bow tie approach is selected is based on the context of the safety in design analysis.

Assess the risk of harm:

- Define the risks arising from design related hazards.
- Identify and evaluate any existing controls.
- Develop the initial risk rating.

Eliminate and control risks:

Eliminate or reduce risks and record justifications in a Safety in Design Risk Assessment. Where health and safety issues are not covered by standards controls are developed in consultation with appropriate stakeholders. Where is it not possible to eliminate identified risks by amending the design, designers must reduce the risk to so far as reasonably practicable. This requires consideration of is known, or ought to be reasonably known, about the risk and any ways of reducing the risk.

Identifying and assessing Potential Control Measures where further risk management is required to treat risks so far as reasonably practicable. Record the decision and justification as to whether the potential control measures are to be implemented or rejected. Potential Control Measures should be identified where existing codes or standards do not eliminate or reduce the risk so far as reasonably practicable. Recognised codes and standards, which regulate the design of buildings and structures, may be used initially to eliminate or reduce risk.

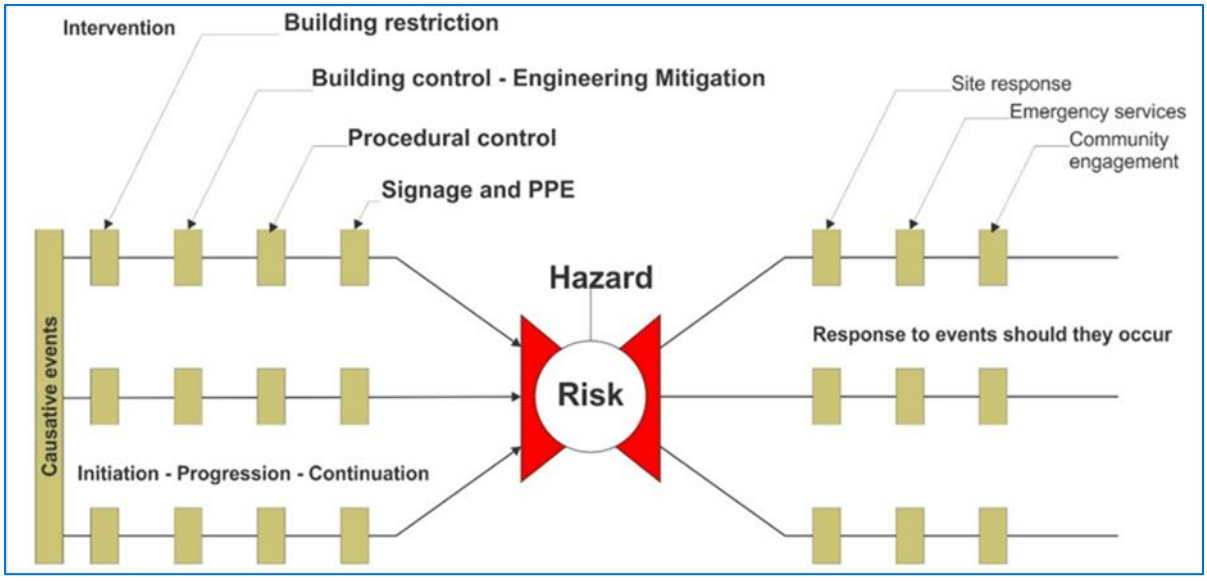


Figure 34: Bow tie assessment methodology

18.3 Safety in Design Risk Outline

A preliminary list of safety in design considerations are provided in Table 44. Integration of control measures to eliminate or minimise risks to health and safety throughout the life of the reservoir will be implemented as part of detailed design.

Table 44: Safety risks mitigated in the feasibility design

Safety risk	Hazard	Mitigations in the design
Construction		
Unusual construction activities:	Injury	The design arrangements adopt common construction methods and practices, thereby minimising unusual activities. Common activities include: General earth moving. HDPE pipe welding. HDPE geomembrane placement. Concrete works. Working in the river There is no requirement for working at heights during construction.
Operation and Maintenance	Injury	Grass mowing – shallow side slopes.
Trips and falls		
Spillway	Injury	Shallow side slopes. Shallow depth.
Fall into the reservoir	Drowning	The riprap on the shallow upstream side slope provides sufficient purchase for an individual to climb out of the reservoir.
Intake Sumps and Pump Chamber	Asphyxiation	No fixed safety features requiring full safety procedures for entry to confined space.
Unauthorised Access	Injury	Security fencing around the perimeter
Draw-off Arrangements on the Crest	Injury	Safety fencing around draw-off valve systems
Decommissioning		
Demolition works	Injury	All works are relatively easy to demolish by competent contractors with a well-planned workplan.

18.4 Residual risks

Although the reservoir, dam and appurtenant structures have been arranged to minimise risks there remain residual risks (Table 45).

Table 45: Residual risks

Safety risk	Hazard	Residual risk
Spillway	Falls	The side slopes of the spillway channel are sloped to remove the possibility of a fall into the channel. However, there remains the risk of a fall into the channel at the upstream end of the channel where the chute forms a side spill channel. General security measures should be considered in detailed design to exclude unauthorised entry to the site and the area, particularly since this is the location of infrequent high energy and turbulent flow conditions.
Draw Off	Diver	The offtake valve is operated from the crest of the embankment. However, a commercial diver may be required to clear any blockage on the inside face of the embankment should this occur. Although the draw off is an emergency drawdown facility, the spillway provides the primary means of controlling the excessive water levels. In addition, the spillway crest wall can be demolished at short notice to draw the water level down by 900 mm at short notice. Consequently, divers will not be at short notice in an emergency should the intakes to both emergency draw off pipes be blocked. Thus, there are no envisaged circumstances where divers might be required at short notice.
Reservoir – open water	Drowning	The presence of a water body is an inherent risk. The side slopes are provided with riprap over the geomembrane to allow persons to crawl out of the reservoir if necessary.

19.0 Cost Estimate

19.1 Introduction

Developing a cost estimate provides information for progressing a decision for development of the project. The physical arrangement and location of the structures has been developed sufficiently to enable preparation of a high-level cost estimate.

The level of cost estimation is based on guidance provided in AACE Practice Note 69R-12 (Hydropower Industry) (2020) (Table 46). The table summarises the characteristics of five estimate classes. The maturity level of a project's definition is the primary characteristic determining the Estimate Class. Although the maturity is roughly related to a percentage of complete definition, it is the maturity that determines the estimate class, not the percentage.

The assessment of cost for the project is based on a feasibility study and therefore has an Estimate Class of 4. This methodology for developing of a cost estimate is considered appropriate in meeting the project cost estimate with an accuracy of -15% to +50%.

Table 46: Estimate Classes from AACE Practice Note 69R-12

	Primary Characteristic	Secondary Characteristic		
Estimate Class	**Maturity Level of Project Definition Deliverables** **Expressed as % of complete**	**End Usage** **Typical purpose of estimate**	**Methodology** **Typical estimating method**	**Expected Accuracy Range** **Typical variation in low and high ranges [a]**
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

Notes: [a] The state of technology, availability of applicable reference cost data, and many other risks affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

19.2 Contingency

Typically, a contingency in a cost estimate refers to a single item covering risks related to potential variations in quantities, rates, and other business risks. Given the feasibility nature of the arrangement a contingency item has not been considered because there is no risk basis on which to assess it.

Notwithstanding the lack of a contingency, this estimate incorporates considerations of the following:

- Appreciation of the effects of “optimism bias” that is often prevalent in the early concept of a project (HMT 2002, HMT 2007 and “Supplement to the Green book”). Although no detailed studies of these effects have been undertaken in New Zealand, observations suggest that the same effects are apparent in the construction industry. The supplement to the Green Book indicates early bias towards and optimistic view of the cost and program (Table 47). A new gate structure would be classed as “Non-standard Civil Engineering”. Consequently, a potential bias is appreciated here, and adjustments made to the estimate by using empirical methods as suggested by HMT 2007.
- Appreciation of, and allowance for, only the foreseeable items of the typical components of a project of this nature.

Table 47: Optimism Bias in Capital Projects

Project Type	Optimism Bias (%)			
	Works Duration		Capital Expenditure	
	Upper	Lower	Upper	Lower
Standard Buildings	4	1	24	2
Non-standard Buildings	39	2	51	4
Standard Civil Engineering	20	1	44	3
Non-standard Civil Engineering	25	3	66	6
Supplement Green Book Guidance – Optimism Bias: based on UK data for outline business case stage projects.				

In the assessment of items some are likely to have a greater degree of certainty than others, and the differences are reflected in the percentage optimism bias assigned to the rates, for example:

- Excavation of soft materials 20 %.
- Dewatering of excavations 60 %.
- Fabricated Steel work 60 %.
- Allowances for items 0 %.

The HMT studies indicate that early optimism bias has several contributory factors. Although optimism in design is a factor in the bias, there are other factors relating to; procurement, funding, external factors such as consents and approvals, as well as external influences such

as changes in legislation or the economy. These factors other than design tend to have by far the largest influence on cost variation through project development.

19.3 Basis of Estimate

The following tables provide descriptions of the basis for the estimate, which is based on the guidance provided by AACE (2020) for a Class 4 estimate.

- Description: The estimate is prepared based on information gained in the feasibility study, and consequently has a related range of accuracy.
- Maturity Level of Project Definition Deliverables: Key deliverable and target status: General arrangement drawings and drawings defining the primary structures. 1% to 15% of full project definition.
- End Usage: Class 4 estimates are prepared for several purposes, such as but not limited to, detailed strategic planning, business case development, project screening at more developed stages, alternative scheme analysis, confirmation of economic and/or technical feasibility, selection of a feasible alternative and preliminary budget approval to proceed to next stage of the project (definition phase).
- Estimating Methodology: The estimate uses stochastic estimating methods such as cost/capacity curves and factors, historical data and other parametric and modelling techniques.
- Expected Accuracy Range: Typical accuracy ranges for Class 4 estimates are -15% to -30% on the low side, and +20% to +50% on the high side, depending on the technological complexity of the project, appropriate reference information and other risks (after inclusion of an appropriate contingency determination). Ranges could exceed those shown if there are unusual risks.
- Alternate Estimate Names, Terms, Expressions, Synonyms: Screening, top-down, feasibility level, definition phase authorisation, factored, pre-design, pre-study.

19.4 Items Not Considered in the Estimate

The scope of the feasibility study does not include the following items:

- Works that might be required at the WTP to accommodate changes in water quality that may occur at the reservoir.
- Any costs incurred within the client’s organisation.
- GST has not been included.

19.5 Basis of Quantities

The estimation for the quantities of each major item is based on the feasibility drawings. The arrangements are based on outline assessments of the hydraulic requirements, which are outlined in the relevant sections of this report. Structural requirement and structural stability have not been considered in developing the concept arrangements.

- **Bulk earthworks** for excavation are estimated from 3D digital terrain models.
- **Engineered earthfill** is estimated from 3D digital terrain models.

- **Structural concrete** is estimated from outline bills of quantities against the feasibility drawings.
- **Other items.**
- **Pipe bridge.**
- **Unscheduled items** are allowances for those items or works that will be required for the completion of the project but have not as yet been identified at this stage of the project. These items should not be considered to be a measure quantity, rate or business risk.

19.6 Basis of rates

The rates used for the study are all-in rates. They have **not** been developed from the basic considerations of all the activities required to complete the components of the works. The rates are intended to:

- Reflect the rates for similar works in 2022. Where rates are adapted from historical works, they are inflated by a compound rate of 2% per annum since the year they were considered appropriate.
- Reflect the general considerations across New Zealand.
- Temporary works, for instance concrete formwork, are considered to be included in the all-in rates.
- Where double handling is thought to be required this has been included the rate.

The rates are not intended to:

- Account for any special factors that might result from the constraints of a pandemic.
- Account for any unique conditions that might be prevalent in the local area.

The rates for major construction items have been developed using experience from similar projects, QV value and reviewed by an independent cost estimating expert. They include:

- **Bulk earthworks** for the excavation of the reservoir. Much of this excavation will be used as fill for the embankments. Given that processing of the materials is probably necessary for, double handling is inevitable.
- **Rip-rap** for the protection of the reservoir side slopes, and reservoir invert. Rounded rip-rap processed from the river terrae excavation is assumed. Therefore, importation of rip-rap to the site is reduced. If required, this material is assumed to be available within 20km of the site.
- **Geosynthetic's** to provide a seepage barrier within the reservoir. These include a geomembrane protected on either face by a heavy geotextile. Much of the cost of the liner system is in surface preparation, installation, quality assurance and protection. Therefore, the choice of material does not greatly influence the cost outcomes.
- **Engineered earthfill** for the dam embankments is both processed and unprocessed materials excavated from the river terrace.
- **Structural concrete** for the draw off supporting slab; and boat ramp.
- **Infrastructure** including:
    - **Roads** for access to the northern abutment of the new gate structure are based on a unit area for the full construction depth of the road over the formation level.
- **Pumping station structural concrete**

- **Pumping station roof**
- **Pumping station pumps, Mechanical and Electrical and pipe work,** including surge suppression air vessels; SCADA systems, Lighting, MVAC, backup diesel generator, air compressor for reservoir air supply and intake backwash systems
- **Rising main** based on twin 280 mm internal diameter HDPE butt fusion jointed pipes, with thrust block and air valves where necessary.
- **Pipe Bridge** to carry the rising main across the Ōhau river. The cost is based on the span to be provided.
- **Power Transmission** is based on a rate per kilometre for a 3 Phase 33 kVA line and pole arrangement.
- **Grid Connection** typically the grid operator charges a lump sum fee for a connection of a power generator source to the national grid. No allowance is made for discounting of the connection if power distribution were to remain local.
- **Unscheduled items** such as miscellaneous utilities.
- **Project development.** Sums are allocated to each of the relevant investigation and development items to provide an understanding of the relative significance of these items. None of these items have been considered in sufficient detail to be considered a reliable estimate. The component items include:

    1. Overheads for the contractors.
    2. Contractor's margin.
    3. Environmental documentation and preparatory works required by the contractor to fulfil consent conditions.
    4. Site mobilisation including the setup of temporary facilities.
    5. Insurances.
    6. QA documentation prepared in advance of works, particularly for those unusual items such as the supply and installation of geomembranes.
    7. Traffic management requirements for site access from public roads.
    8. Commissioning requirements.

19.7 Estimate

The estimate for the works considers the cost for a new structure separately from any additional costs reasonably be attributed to the concurrent development of a hydropower facility in the new structure. The estimate is the summation of approximately one hundred individual items.

The estimated cost for the construction of a new structure is summarised in the following tables (Table 48). The potential confidence limits on the estimate is – 15% and +50%.

Table 48: Project Estimate

Poads Road Reservoir and ancillary works	
Item	**Estimate $**
P&G: Preliminary and General	17.6 million
River intake: Infiltration gallery Ōhau River, pumping station and rising main to reservoir	3.2 million
Reservoir: formation embankments, geosynthetics, groundwater drainage, spillways, and boat ramp	23.8 million
Draw off: Reservoir arrangement, Pumping station, compressed air supply for water quality	0.6 million
Rising main: Twin rising mains from pump station to treatment plant	6.6 million
Pipe bridge	3.1 million
Transmission: Connection to grid, power transmission and connection	0.6 million
Infrastructure: Roads, fencing, comms	1.9 million
Unscheduled items - Miscellaneous utilities.	1.0 million
Total construction works	**58.4 million**
Project development: Design costs, Consenting	9.3 million
Total project works	**67.7 million**
Range (-15% - +50%)	**57.5 – 101.6 million**

20.0 Constructability

20.1 Introduction

The constructability of the project requires several considerations and must incorporate various constraints:

- A construction contract arrangement matching the design and performance expectations for the project, which includes appropriate specifications.
- The site area is nearly fully occupied with permanent works. Additional temporary areas nearby are required to provide sufficient areas for a contractor's temporary works, lay downs areas and other contract functions.
- Services passing through, across or near to the site.
- Traffic management.
- Interfaces with, and working within, the Ōhau River.
- Specific construction activities requiring specific construction controls.
- Commissioning actives.
- The anticipated programme for completing the work.

20.2 Contract arrangements

The structure for the construction contract should match the design objectives and the specifications developed for the works. The feasibility design adopts physical and mechanical properties of materials that are typically used in New Zealand. If a different contract model is adopted, then the specification and perhaps the contract drawings will require altering to suit the contract model.

The feasibility study envisages the following contract model which is commonly adopted in New Zealand for works of this nature to meet the requirements of the Building Code and the guidance of the NZDSG:

- A Contractor with suitable experience and qualifications will be engaged under contract to undertake the construction of the works.
- An Engineer with suitable qualifications will be engaged to supervise the construction of the works.
- Method, rather than performance, specifications are adopted to reduce the extent of testing required during construction.
- A PS4 will be required following completion of the works as part of the documentation to support and application for a CCC (Code Compliance Certificate) from the relevant Building Authority.

20.3 Existing and Future Services

The presence and extent of services within the site area will be investigated in the detailed design. However, some pertinent observations can be made at this stage:

- Gladstone Road: Services are likely to be present along Gladstone Road, including telecoms, water supply, and overhead power lines.

- Poads Road: Services are likely to be present along Gladstone Road, including telecoms, water supply, and overhead power lines.
- Old water supply pipes: The old raw water supply line runs along the northern boundary of the site to a series of water tanks on the adjacent land to the north of the site. The works may interface with specific section of this line. In the detailed design any requirement to preserve these works will be investigated.

The construction methodology must also provide for the following traffic management issues:

- Gladstone Road: Maintain traffic flows whilst constructing the rising main along the road corridor.
- Poads Road: Maintain traffic flows along Poads Road
- Poads Road Bridge: Maintain access and site lines along Gladstone Road and over the Poads Road Bridge whilst building the right abutment foundation to the pipe bridge.

Currently Poads Road extends to and services a car park and farm buildings at the end of the road. The footprint of the reservoir will sever the road prior to these facilities. Therefore, the road must be realigned prior to the commencement of works, and road access must be maintained throughout the works period. The car park will be re-provisioned.

20.4 Existing Structures

The proposed reservoir site has no significant structures requiring removal prior to construction. Minor structures such as trees and fencing must be removed as necessary prior to construction.

The construction of the intake and spillway will probably sever the decommissioned HDC water supply. If encountered, there is no intention to re-instate the pipeline.

20.5 River intake

The Ōhau riverbed close to, and about 50 m upstream of the reservoir is approximately 80 m wide at the nominal flood river level. The water is to be abstracted from an infiltration gallery buried in the riverbed and pumped from the riverbank collection sumps to the reservoir. To provide flexibility of operation and maintenance the intake consists of two independent infiltration galleries and attendant facilities.

The final arrangement will depend on investigations of the riverbed to establish the likely water flow yield form the riverbed gravels to the infiltration gallery.

The anticipated construction sequence for the Intake comprises the following. In developing this sequence best practice techniques are incorporated, as described by MoE’s National Works in Waterways Guidelines (2021):

1. Construction of a channel to divert the river flow away from the intake construction footprint.
    a. Construction works are to be undertaken in low flow seasons to reduce river levels. Discussions with Fish and Game should be initiated to align works with non-critical times for fish spawning and migration.

2. Depending on anticipated river flows and natural groundwater levels, construction of further barriers may be required, such as Aquabarrier, bunds and supplemented by temporary sumps and pumps to intercept groundwater flow entering the excavation.
    a. These temporary sumps and pumps in the riverbed would likely be installed at low points at the edge of the proposed infiltration gallery footprint.
        i. Suitable fish screens or covers can minimise the drawing of freshwater fauna into the pumps.
    b. Robust sediment control techniques, such as silt fences, will minimise construction impacts.
3. The infiltration gallery area will be excavated by suitable plant to the design level below the riverbed.
    a. Larger material encountered in the riverbed will be harvested and stockpiled for later use on the riverbed surface of the completed infiltration gallery.
    b. Permeable gravel drainage material will be placed to the design thickness inside gabion basket type structures and compacted to appropriate standards in the gallery footprint.
    c. Perforated pipes and backwash pipework will be placed in drainage material so that it surrounds and covers the pipework in the gabion basket.
    d. Harvested material will be placed over the permeable gravel layer to provide an armouring to the riverbed and riverbanks to inhibit general riverbed scour.
4. Shallow trenches from the infiltration pipework to the sedimentation sumps will be excavated and pipes installed to join the infiltration galleries to the sumps. Pipework will be installed with suitable drainage material surround.
5. The sedimentation sump and submersible pump sump will be constructed in the nearest river terrace by a suitable excavator, either by trenching in from the riverbank or excavation from ground surface. The approach is still to be assessed and determined.
    a. Each sump will be constructed by
        i. Forming a cast in-situ reinforced base slab (approx. 500 - 700mm thickness),
        ii. Placing sections of pre-cast concrete rings installed which will form the permanent formwork for the cast in situ structural wall.
        iii. Pre-cast concrete rings will be soaked prior to placement.
        iv. The internal structural wall will be cast in place concrete.
        v. Natural soils and gravel will provide the backfill surround.
6. Two platforms will be cut in to reduce the height of both the sump and sedimentation manhole.
    a. Cuts will be stabilised using Mechanically Stabilised Earth slopes or similar.
    b. Appropriate fencing / guard rails will be provided on the crest of the riverbank for Health and Safety.
    c. River protection works will be constructed along the river in the location of the galleries. Protection measures are likely to be riprap revetments toes into the riverbed.
7. Upon completion of the river works all diversion features and equipment will be removed and the riverbed restored.

Other considerations:

1. Access to the site will be created from the closest riverbank / terrace. Vegetation clearance will be required.

2. Suitable plant will be determined by the preferred Contractor. Excavators are likely to be 20 tonnes or more.
3. It is anticipated that machinery working in the river, in accordance with approved method statements, will be sprayed down and washed prior to river entry in a suitable bunded location, to minimise and avoid the spread of freshwater plant and animal pests, and discharge of contaminants.
4. Fuels and other chemicals for plant will be stored away from the waterways and above the anticipated flood levels.
5. Any riverbank zones not required for permanent access will be reinstated to their previous contours and revegetated and river protection.

20.6 Earthworks

The feasibility design of the reservoir is arranged to make the best use of the materials, the terrace gravels, on site. However, the excavation of the terrace gravels must be processed to provide:

- Bulk earth fill
- Filter materials
- Drainage Materials
- Riprap.

The topsoil materials will be stripped from beneath the footprint during construction. Removal of the topsoil material must be verified, particularly along the northside of the embankment foundation, where the ground level is 118 m RL.

The feasibility design assumes embankment materials will be primarily sourced by processing materials from site excavations. Excavation depths increase towards the reservoir's southern end, which follows two sloped terraces. The potential excavation depths vary between 3 m to 12 m within the reservoir's footprint.

However, if there is deficit the assumption is that the materials can be imported from sources nearby, likely less than 10 km away.

Processing of granular materials would likely require an area in the land immediately to the north of site. The equipment and areas necessary for processing materials would include:

- Conveyors.
- Hoppers.
- Crushers.
- Vibrating screens with various filters for specific particle sizes.
- Storage stockpiles.
- Diesel generators and diesel fuel storage.

Most of the construction, the earthworks in particular, are likely to occur in summer periods, when the disturbance of fine soil can lead to dust. The contractor will be responsible for the control of dust. Dust control methods are typically water sprays to minimise the generation of dust on:

- Haul roads.
- Excavation surfaces.
- Material stockpiles.

20.7 Liner systems

The liner system is to be installed across the full extent of the reservoir. This consists of an HDPE low permeability geomembrane with adequate protection by geosynthetic geotextiles. In addition, across the base there is a groundwater collection layer of granular drainage materials and HDPE collection pipes embedded within it.

These systems require specialist expertise and knowledge to install and are typically undertaken by a specialist subcontractor. Given the importance of establishing the integrity of the liner system, specific quality assurance systems and quality procedures are implemented, and records maintained. These specialist subcontractors provide temporary weights to resist wind uplift during construction.

When placing and trimming the geosynthetics to the shapes of the reservoir bowl there are inevitably offcuts that cannot be used in the permanent works. These offcuts require disposal, and this responsibility is typically written in the construction contract as the contractor's responsibility.

The requirements for the systems and procedures are defined at the detailed design stage and then defined by the specialist contractor to meet the performance requirements and industry standards.

20.8 Pumping station and rising mains

The pumping station requires the construction of various components and facilities including, some of which might be altered in the detailed design stage:

- Reinforced concrete substructure.
- Structural steel superstructure and steel roofing.
- Mild steel pipe works.
- Pumps and valves.
- Electrical wiring and control systems.
- Emergency and security systems.

Within the same area there are likely to be the following ancillary facilities:

- Air bubbler systems for the oxygenation of the water in the reservoir.
- Electrical transformer for the facility.
- A spares and workshop building.
- A diesel standby generator and fuel tank to provide power in the event of a loss of electrical power from the grid supply.

Each of these require concrete foundations and structures to house them.

20.9 Pipe bridge

The current feasibility concept for the pipe bridge is an open streel work trust, providing a single span across the Ōhau river upstream of the current Poads Roads bridge. At each abutment there will be engineered foundation and bearings allowing the pipe bridge span to rotate in response to an earthquake.

The abutment works are likely to include:

- **Left abutment**: A concrete pad to support roller bearings so the bridge span can move in two dimensions in response to an earthquake. Also, there will be a transition area beyond the span to allow the HDPE rinsing main pipes to rise out of the buried trench before being fixed to the bridge deck.
- **Right abutment**: A deep concrete foundation in the rock to encase a large diameter vertical bearing manufactured in steel. This allows the bridge to rotate without losing its positional fixing. In addition, there will be a transition area to allow the rising main pipes to transition back into a buried trench alongside Gladstone Road.

The contractor engaged to manufacture and install the bridge is likely to be a specialist contractor. This contractor is likely to adopt a construction and installation method of the span that best suits the contractor's experience and working practices. Methods that might be employed or investigated could include:

- Manufacture the span in large sections and transport to site for assembly.
- Assemble the sections in the relatively clear are on the left bank of the Ōhau River immediately upstream of the road bridge.
- The installation of the span might be:
    - Push the whole span from the left back across the river as a single cantilever to the right abutment.
    - Push the span from the left back to rest on temporary intermediate supports in the riverbed.
    - Use a heavy crane to lift the span into place.

20.10 Quality Control

Safety of the reservoir depends on robust design and quality construction, followed by an appropriate dam safety management program to maintain the reservoir in a safe condition. An integral component of dam safety is a comprehensive construction quality assurance programme.

The NZDSG indicate that Medium PIC classified dams should include designer supervision during construction, including a robust construction quality assurance programme.

The detailed design stage will define the construction supervision and quality assurance necessary for construction in accordance with the NZDSG, which will reduce potential dam safety risks.

20.11 Commissioning

Commissioning of the reservoir provides the first test of the design and construction and will be completed when the pond is full and operated for approximately 6 months.

Experience has shown that inherent dam safety issues are often disclosed during commissioning and in the first years of operation. Strategies which maximise the opportunity to monitor performance against expectations are therefore critically important during this early period from a dam safety viewpoint.

A Commissioning Plan will be developed during the construction phase. Commissioning to achieve and maintain dam safety will be in accordance with the NZDSG.

20.12 Program

The tentative program for the development construction and commissioning of the scheme is based on a conventional development program. The program typically includes a phase for planning, development and procurement, and the second in construction and commissioning.

Opportunities to accelerate the program are limited. Most of the preparatory works are procedural and cannot be circumvented. Latter parts of the implementation program might be accelerated by early contractor involvement, but various governance processes would require modifications to achieve this early involvement.

The construction program will be elaborated in stages throughout the detailed design phase, Building Consent preparation and procurement.

20.12.1 Planning Development and Procurement

Planning and programming activities are typically:

- Feasibility Study completion and approval.
- Resource Consent under the RMA process.
- Detail Design including scoping and studies.
- Building Consent including application and queries.
- Procurement including documentation, tenders, tender evaluations, and award.

Within this group of activities there are likely to be several stages of scheme development and iteration towards preferred arrangements based on functionality, resource, and financial constraints.

Some activates might be progressed in parallel, such as

- Resource consent processes, detailed design.
- Building Consent and procurement.

However, experience on other projects suggests these opportunities are limited. Rather there is greater likelihood that any optimistic program will be extended by procedural processes. Therefore, the current period for this planning phase of two years may be subject to extension rather than a contraction.

20.12.2 Construction and Commissioning

The second phase of construction and commissioning are:

- Preparatory works including provisioning of roads and utilities along Poads Road
- Contractors set up of facilities.
- Construction of works, including the river intake, the reservoir, and associated facilities, the rising main and the pipe bridge over the Ōhau river.
- Commissioning.

The period required to complete the works is dependent on the season in which the contracts are awarded, the number of summer construction seasons available for construction, and adverse weather or ground conditions. The total length of this phase might be 2.5 to 3 years, preferably with 4 summer construction seasons.

21.0 Conclusions

The Poads Road Water Supply scheme consists of a series of components that collectively deliver water to the Levin Water Treatment Plant to augment and enhance the current arrangements. The components include:

- River intake on the river Ōhau close to the reservoir site, with associated pumps and rising mains to the reservoir.
- Offline reservoir, confined by an embankment dam on the northern perimeter.
- Spillway to discharge excess water to protect the embankment from overtopping.
- Off take valves and pipe work to convey water to the downstream toe.
- Emergency drawdown facilities to discharge water to the lower section of the spillway.
- Pumping station and rising main to the Levin Water Treatment plant.
- Pipe bridge to convey the rising mains over the Ōhau River.

The earth embankment dam has a Medium Potential Impact Category. A hypothetical failure would put a limited number of people at risk and would incur some damage downstream. For this reason, the dam's feasibility design adopts appropriate performance criteria in accordance with accepted practice (NZDSG).

Detailed design of the works will be developed to meet the requirements of the Building Code. The principal considerations for design and construction are that the dam should achieve (Davidson, 2019), without introducing unnecessary conservatism:

- **Resilience** – the ability to avoid, minimise, withstand, and recover from the effects of adversity, whether natural or manmade.
- **Robustness** – the ability to continue operation across a range of events and conditions, which is achieved by incorporating overlapping design measures against adverse conditions.
- **Reliability** – the effectiveness of design measures in overcoming adverse conditions.

Issues of applicability:

- Although the intake arrangement is intended to be resilient, the shallow depth of burial for the gallery in the riverbed is inherently vulnerable to a changing riverbed regime. The design requires further investigation at the detailed design stage and recognition of the long-term vulnerability of such facilities and its maintenance requirements.
- The dam forms an offline reservoir; therefore, construction is not constrained by considerations of flood management.
- The freeboard provided in the design is governed by the freeboard to the crest of the geomembrane.
- The foundations are expected to be soft; therefore, the design assumes that the embankment's construction will commence and be substantially complete in the driest part of the year.
- Construction requires specialist contractors to provide and install the geomembrane.
- Construction requires supervision by a suitably qualified engineer.
- Construction requires appropriate quality and tolerance control to implement the design.

22.0 Limitations

This report has been prepared by Damwatch Engineering Limited solely for the benefit of Horowhenua District Council. No Liability is accepted by Damwatch or any director, employee, contractor or sub-consultant of Damwatch with respect to its use by any other person.

This disclaimer shall apply notwithstanding that the report may be available for other persons for an application for permission or approval or to fulfil a legal requirement.

In order to assess the suitability and quantity of materials at the proposed reservoir, site investigation and soils testing were carried out as part of this study. The feasibility design has been prepared based on these site investigations, results of the testing programme, and the evaluation of this information, as set out in this report.

The design of all control systems, hydraulic gate(s), flow measurement and instrumentation systems are outside the scope of this preliminary design.

Details on construction methodology (i.e., sequencing of major activities, timeframes, access point and vehicle crossing standard, spoil disposal location, storm-water management, erosion and sediment control, dust management, etc) are outside the scope of this report.

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Appendix A Drawings

POADS ROAD
(Drawing List)

1. General Drawings And Sections

- PDR2142/30/103 Locality Plan
- PDR2142/30/104 General Layout Plan
- PDR2142/30/107 Geological Investigation Plan
- PDR2142/30/108 Geological Sections G1 And G2

2. Infiltration Gallery / River Intake, Pumping Station And Rising Main To Water Treatment Plant

- PDR2142/30/121 River Intake - Plan, Section of Pump and Sedimentation Sump
- PDR2142/30/122 River Intake - Pump Sump Plan, Section And Reinforcement Details
- PDR2142/30/123 River Intake - Sedimentation Sump Plan, Section And Reinforcement Details
- PDR2142/30/124 Drawoff Pumping Station - General Arrangement

3. Embankment Sections And Details

- PDR2142/30/130 Reservoir Embankment Section Y
- PDR2142/30/131 Reservoir Embankment Sections Z, ZA, ZB and ZC

4. Drawoff Arrangements And General Arrangement

- PDR2142/30/141 Drawoff Arrangement - Section Z1 General View
- PDR2142/30/143 Drawoff Schematics And Pipe Surround Details
- PDR2142/30/144 Drawoff General Arrangement - Upstream Pipe Surround, Detail Section And Thrust Block Reinforcement

5. Spillway

- PDR2142/30/160 Spillway - Plan Arrangement
- PDR2142/30/162 Spillway - Sections S2A, S2B And S2C
- PDR2142/30/164 Spillway - Sections S4 And S5

6. Emergency Drawdown - Vertical Stilling Well

- PDR2142/30/171 Vertical Stilling Well - Plan, Section And Reinforcement Details

7. Dam Safety Monitoring Equipment

- PDR2142/30/180 Weir V-Notch Crest - Plan and Isometric view
- PDR2142/30/181 Settlement Monitoring Point and Well - Typical Section And Details
- PDR2142/30/182 Groundwater Collection and Lateral Pipes - Section And Typical Details

8. Rising Main to Water Treatment

- PDR2142/30/190 Rising Main - Typical Sections And Details

9. General Details

- PDR2142/30/220 Boat Ramp Location Plan, Section And Typical Details
- PDR2142/30/301 Standard Drawing Notes
- PDR2142/30/302 Standard Details

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issue For Comment	FS	JE	S.M.	16/03/23

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title: HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

DRAWING LIST

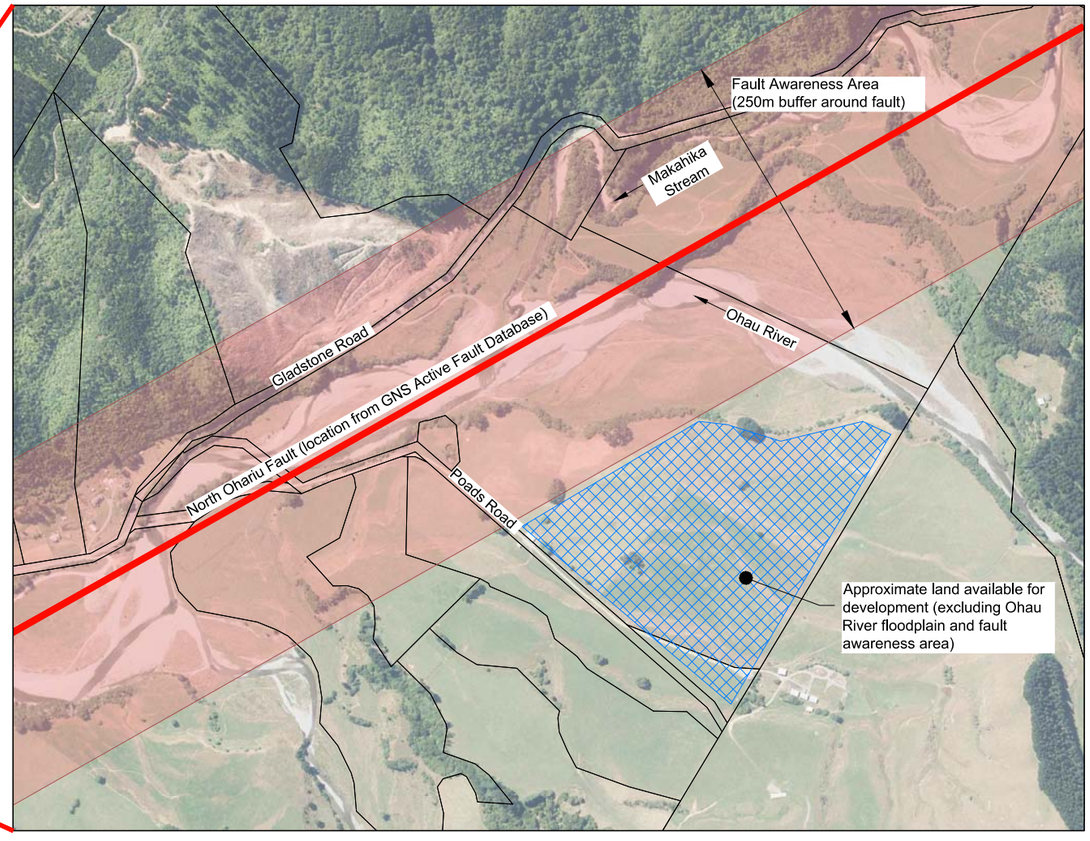
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Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
info@damwatch.co.nz
+64 4 381 1300

23 February 2023 11:28am
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Graphic Scales
Original Sheet Size A3 (420x297)



LEVIN AND SURROUNDS
1:100,000 -



SITE LOCATION MAP
1:10,000 -

Notes

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issue For Comment	FS	JE	S.M.	16/03/23

Graphic Scales
1:100000 0 1 2 3 4 5 km
1:10000 0 100 200 300 400 500 m

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

LOCALITY PLAN

Scale	Project	Drawing Number	Revision
AS SHOWN	E2142A	PDR2142/30/103	R1

Original Sheet Size A3 (420x297)

A Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
E info@damwatch.co.nz
P +64 4 381 1300

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Notes Keys and References

Standpipe Piezometer Coordinates				
Point #	Northing	Easting	Elevation (mRL)	ID
1	5496314.83	1799307.28	131.88	SP-1
2	5496439.90	1799145.00	131.88	SP-2
3	5496531.30	1799149.89	131.88	SP-3
4	5496587.65	1799259.67	131.88	SP-4
5	5496599.81	1799330.73	131.88	SP-5
6	5496580.85	1799470.02	132.00	SP-6
7	5496505.44	1799520.42	131.88	SP-7
8	5496445.95	1799482.84	131.88	SP-8

Proposed access road refer dwg PDR2142-30-102
Open channel
Proposed monitoring weir location (refer dwg PDR2142-30-180)
Pumping Station, Diesel Generator, Bubbler facility, Transformer Stores, EVA turning circle
EVA turning circle (indicative)
Ohau River
Carpark
Pavement
West Toe drain
Ground Water Toe drain
East Toe drain
Pumping Station
Diesel Gen
Bubbler Facility
Spillway
Vehicle access (indicative)
Infiltration Gallery
Sedimentation Sump
Pump Sump
Intake
Pump Sump Intake
Thrust block For detail, refer dwg PDR2142-30-144
Refer dwg PDR2141-30-124
Draw Down Vertical Stilling Well refer dwg PDR2141-30-171
Twin Rising Main to WTP refer dwg PDR-30-190
Proposed Boat Ramp Refer dwg PDR2142-30-220
SP- 1
SP- 2
SP- 3
SP- 4
SP- 5
SP- 6
SP- 7
SP- 8
2 x Upper, 2 x Lower, Draw-Off For general arrangement/detail, refer dwgs PDR2142-30-143,144.
Lateral Pipes (10 nos.) with 40m spacing
Spine Pipe Arrangement refer dwg PDR2142/30/182
Infiltration gallery detail layout refer dwg PDR2142-30-121
5.0m corridor for maintenance access and site fencing.
Refer dwg PDR2141-30-181
3.0m corridor for maintenance, site fencing and planting (if required).
Embankment crest
Existing access to farmhouses
Poads Road parcel boundary
Concrete beam near upstream end of spillway (refer dwg PDR2142-30-164)
Poads Road boundary parcel approximately 15.0m wide
3.0m corridor for maintenance, site fencing and planting (if required).
Embankment crest. Access to spillway.
13.0 m corridor for bypass access
Existing Parcel Boundary
Farmhouses
N

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R3	Reservoir shifted, setbacks noted, coords updated	R.L.	J.E.		
R2	Reservoir shifted	R.L.	J.E.		
R1	Issue for Comments	FS	JE		

Notes:

1. All co-ordinates are to NZTM and levels are to NZVD2016 mean sea level.
2. Site boundaries sourced from LINZ database.
3. Embankment set-back 6 metres minimum from site boundaries.
4. Contours from LINZ LiDAR survey 2016.

Existing Parcel Boundary

8 No. Survey mark central on embankment crest. Refer BCI1613/30/52 for detail.

SP- x 8 No. Standpipe piezometers on embankment crest.

Graphic Scales 1:2500 0 20 40 60 80 100 120 m

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

GENERAL LAYOUT PLAN

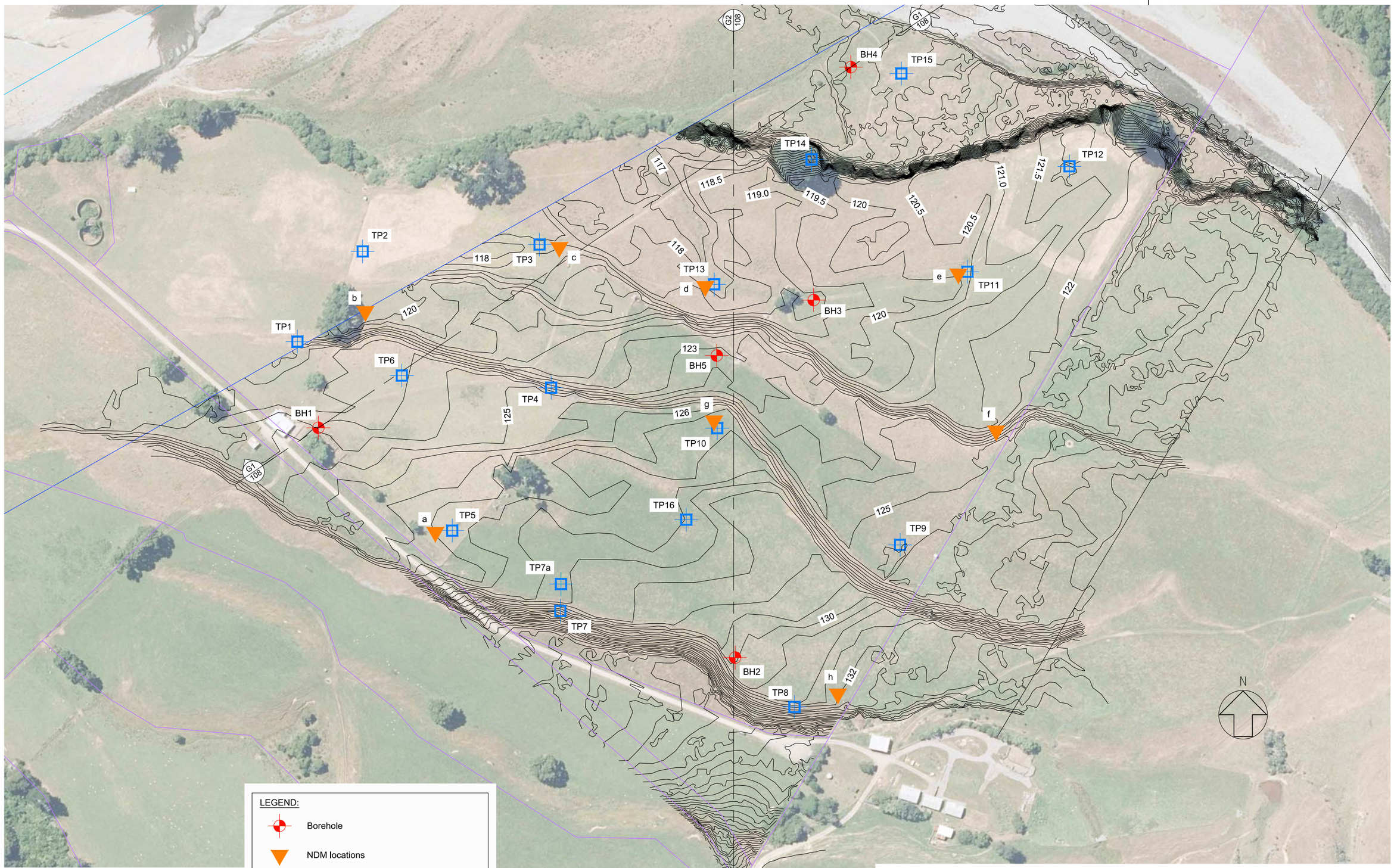
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Original Sheet Size A3 (420x297)

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info@damwatch.co.nz
+64 4 381 1300

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Notes Keys and References



LEGEND:

- Borehole
- NDM locations
- Testpit
- Land parcel boundary
- Existing overhead power lines (approx.)
- 250m offset from Northern Ohariu Fault Line

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	ISSUED FOR COMMENT	FS	JE	S.M.	16/03/23

Graphic Scales 1:2500 0 20 40 60 80 100 120 m

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

GEOLOGICAL INVESTIGATIONS
PLAN

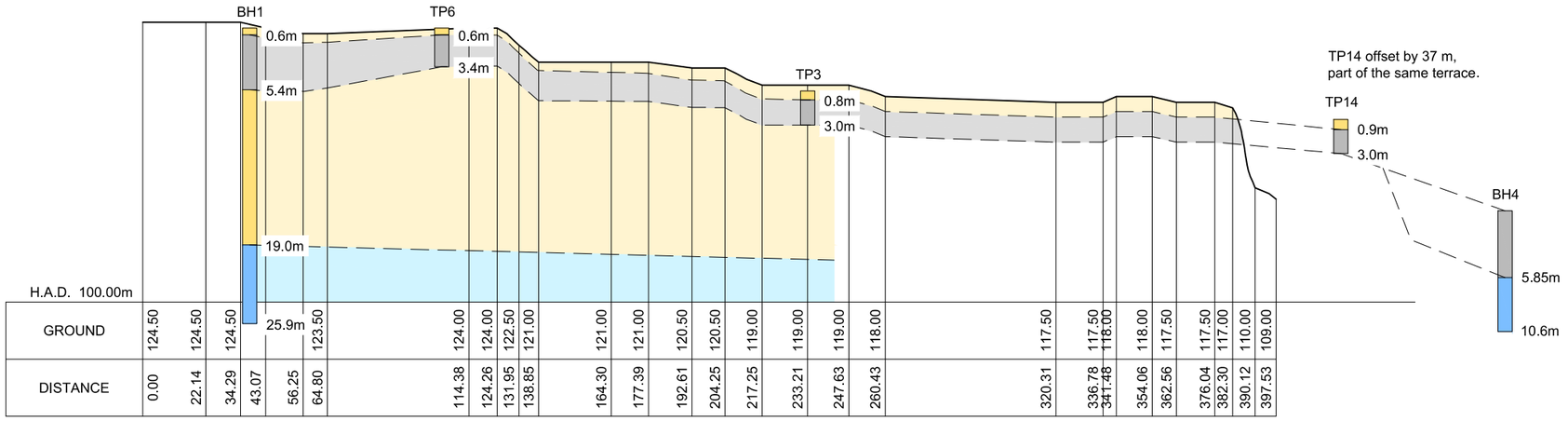
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Original Sheet Size A3 (420x297)

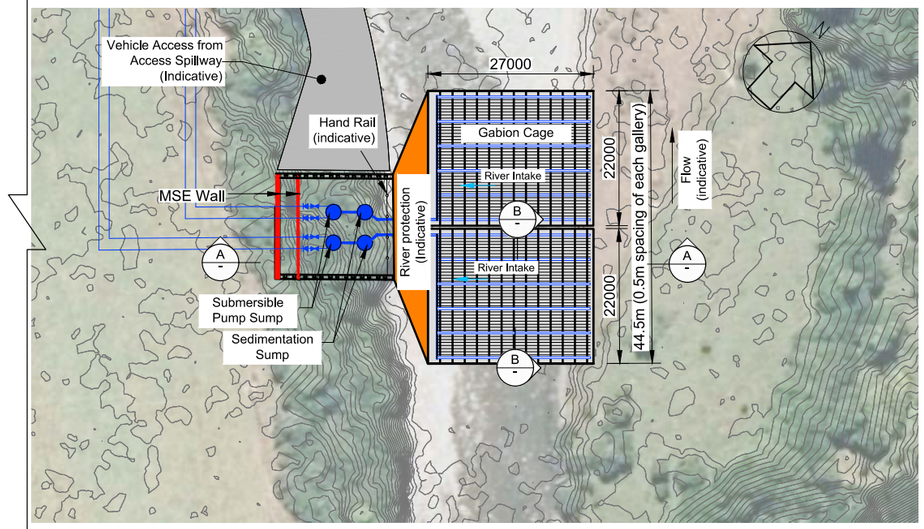
A Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
E info@damwatch.co.nz
P +64 4 381 1300

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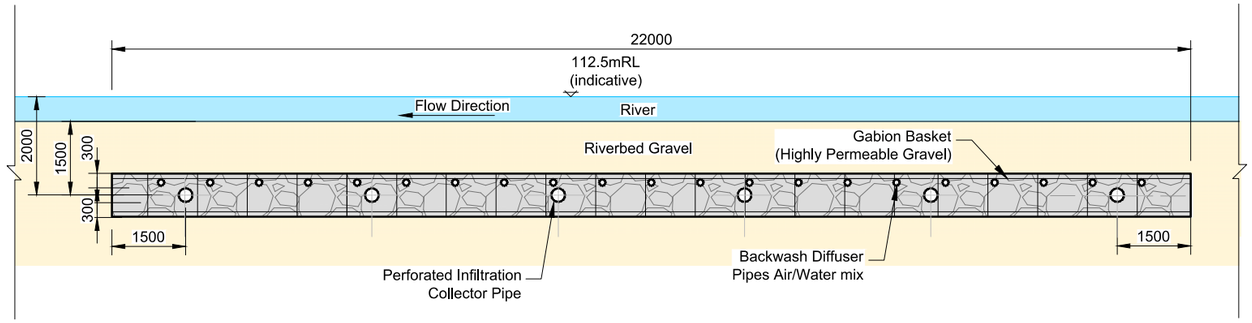
Notes Keys and References



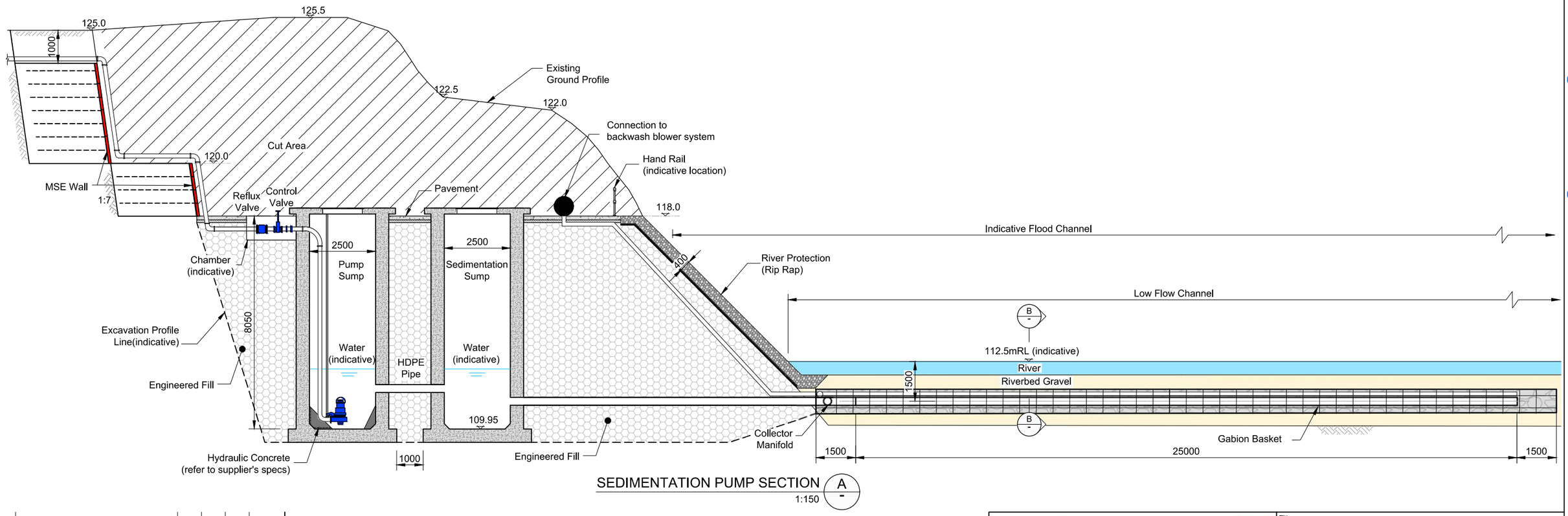
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INFILTRATION SUMP LAYOUT PLAN -/- 1:500



TYPICAL PEFORATED INFILTRATION SECTION B/- 1:125



SEDIMENTATION PUMP SECTION A/- 1:150

Notes:

1. All co-ordinates are to NZTM and levels are to NZVD2016 mean sea level.
2. Site boundaries sourced from LINZ database.
3. Embankment set-back 6 metres minimum from site boundaries.
4. Contours from LINZ LiDAR survey 2016.

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issue for Comment	FS	FZ	S.M.	16/03/23

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

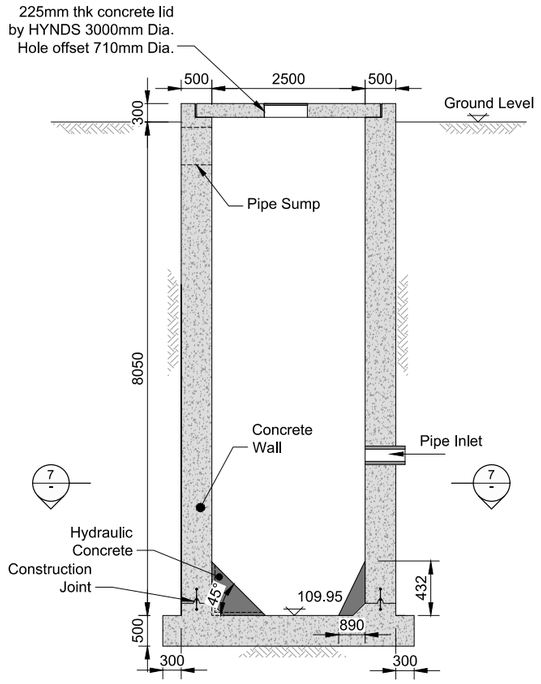
Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

RIVER INTAKE
PLAN, SECTION OF PUMP
AND SEDIMENTATION SUMP

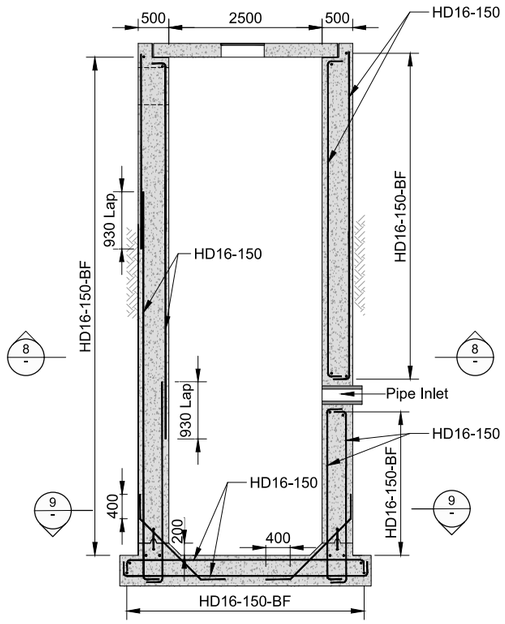
Scale	Project	Drawing Number	Revision
AS SHOWN	E2142A	PDR2142/30/121	R1

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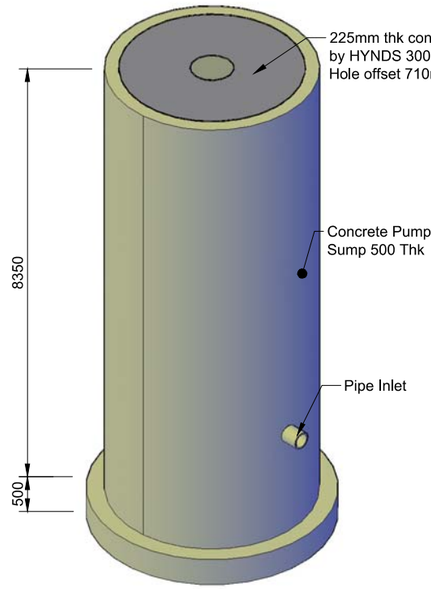
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Graphic Scales
Original Sheet Size A3 (420x297)



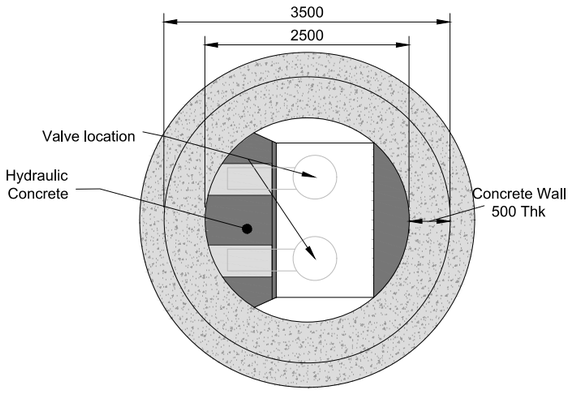
PUMP SUMP
1:100 (-)



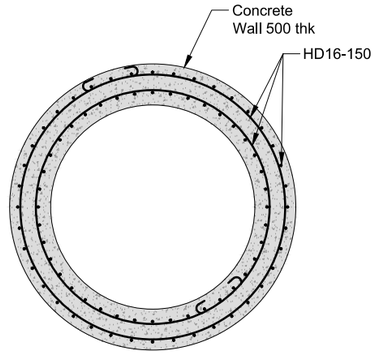
PUMP SUMP REINFORCEMENT
1:100 (-)



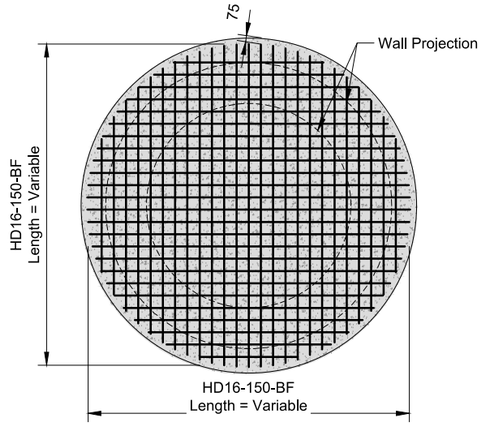
ISOMETRIC VIEW OF PUMP SUMP
1:100 (-)



PUMP SUMP SECTION 7
1:75



PUMP SUMP REINFORCEMENT 8
1:75



PUMP SUMP SLAB REINFORCEMENT SECTION 9
1:75

Notes:

1. Characteristic compressive strength of concrete shall be 30MPa at 28 days.
2. Reinforcing in accordance with NZ codes and standards (NZS3101, 3109, ASNZS 4671, etc.).
3. Minimum concrete cover to reinforcement bars shall be: 75 mm cast against ground, 50 mm typical.
4. All dimensions shall be verified by the contractor before commencing work
5. This drawing shall read in conjunction with other drawings
6. Drawings shall not be scaled for dimensions.
7. Specific details for the concrete lid will be provided in design stage as well as the additional reinforcement around openings.
8. The concrete lid shall allow to be lifted and must consider an opening access.
9. Pump provider shall provide technical specifications for pump's installation including hydraulic concrete specifications.
10. Pipe sump shall be fixed to the wall concrete with steel saddles according to provider requirements.
11. Concrete sump must include steel steps for maintenance and having access to the structure. Their specification will be provided in design stage.

HD12-150-BF
- EW - Each Way
- BF - Both Faces
- TB - Top Bottom
- Max. Spacing (mm)
- Nom Bar Dia. (mm)
- Bar Grade and Type

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issue for Comments	FS	FZ	S.M.	16/03/23

Graphic Scales
1:100 0 1 2 3 4 5 m
1:75 0 1 2 3 m

Horowhenua DISTRICT COUNCIL
DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

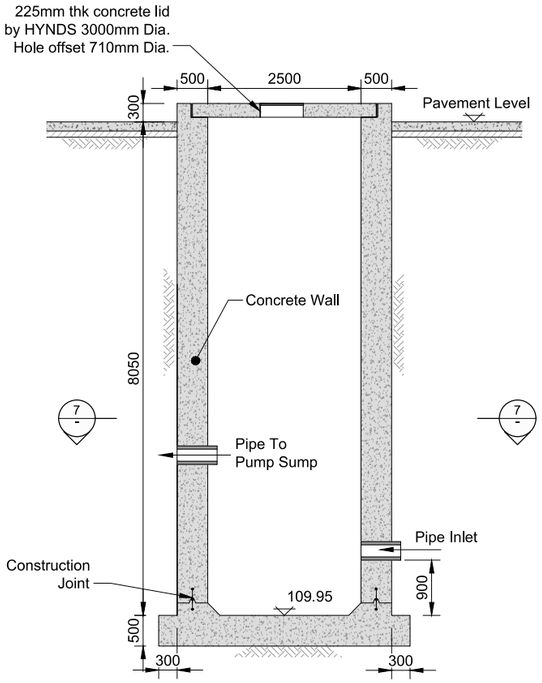
RIVER INTAKE
PUMP SUMP PLAN,
SECTION AND REINFORCEMENT DETAILS

Scale	Project	Drawing Number	Revision
AS SHOWN	E2142A	PDR2142/30/122	R1

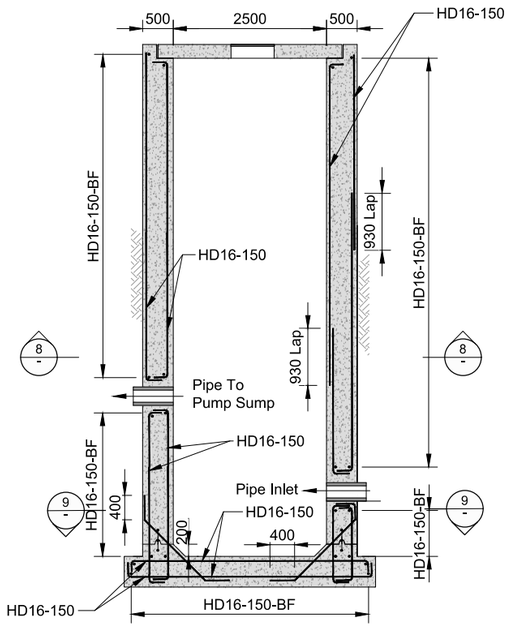
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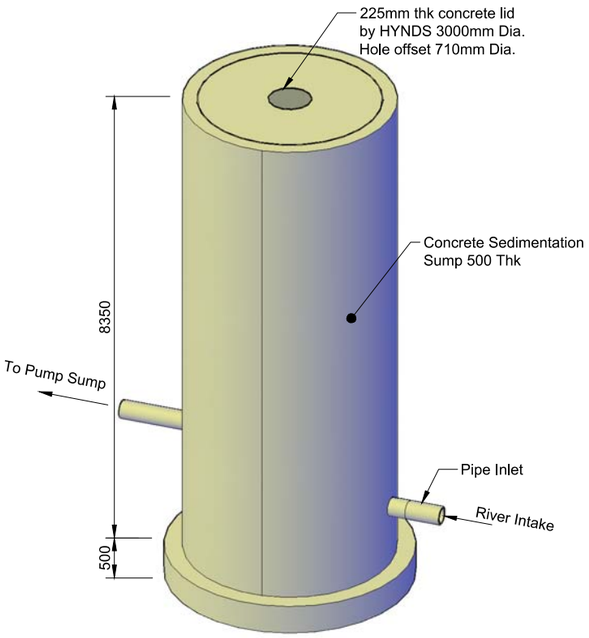
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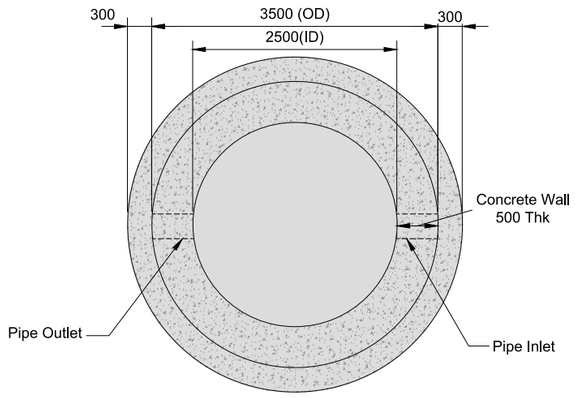
SEDIMENTATION SUMP
1:100 (-/-)



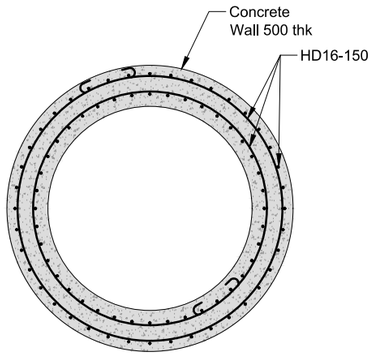
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1:100 (-/-)



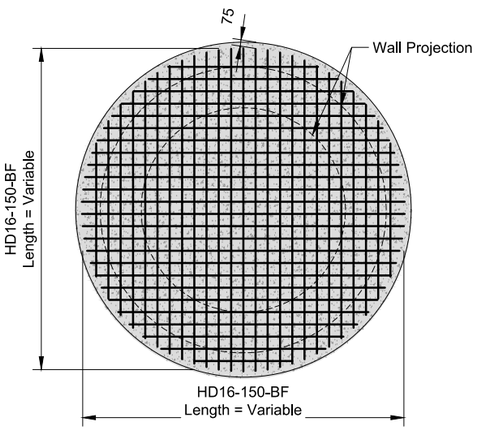
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1:100 (-/-)



SEDIMENTATION SUMP SECTION
1:75 (7/-)



SEDIMENTATION SUMP REINFORCEMENT
1:75 (8/-)



SEDIMENTATION SUMP SLAB REINFORCEMENT SECTION
1:75 (9/-)

Notes:

1. Characteristic compressive Strength of concrete shall be 30MPa at 28 days.
2. Reinforcing in accordance with NZ codes and standards (NZS3101, 3109, ASNZS 4671, etc.).
3. Minimum concrete cover to reinforcement bars shall be: 75 mm cast against ground, 50 mm typical.
4. All dimensions shall be verified by the contractor before commencing work
5. This drawing shall read in conjunction with other drawings
6. Drawings shall not be scaled for dimensions.
7. Specific details for the concrete lid will be provided in design stage as well as the additional reinforcement around openings.
8. The concrete lid shall allow to be lifted and must consider an opening access.
9. Concrete sump must include steel steps for maintenance and having access to the structure. Their specification will be provided in design stage.

HD12-150-BF
- EW - Each Way
- BF - Both Faces
- TB - Top Bottom
- Max. Spacing (mm)
- Nom Bar Dia. (mm)
- Bar Grade and Type

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issue for Comments	FS	FZ	S.M.	16/03/23

Graphic Scales
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Horowhenua DISTRICT COUNCIL
DAMWATCH ENGINEERING BEYOND THE SURFACE

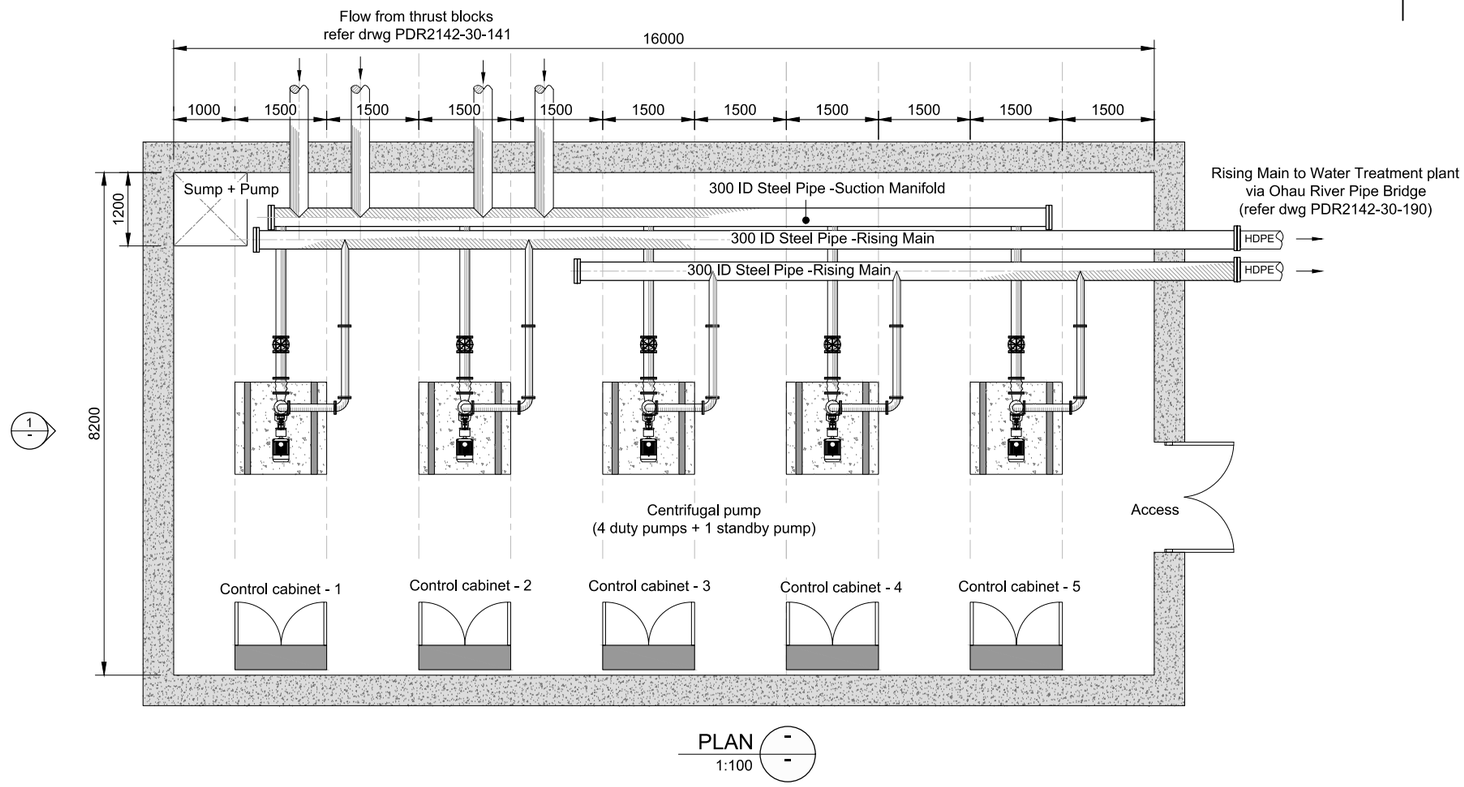
Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR
RIVER INTAKE
SEDIMENTATION SUMP
PLAN, SECTION AND REINFORCEMENT DETAILS

Scale	Project	Drawing Number	Revision
AS SHOWN	E2142A	PDR2142/30/123	R1

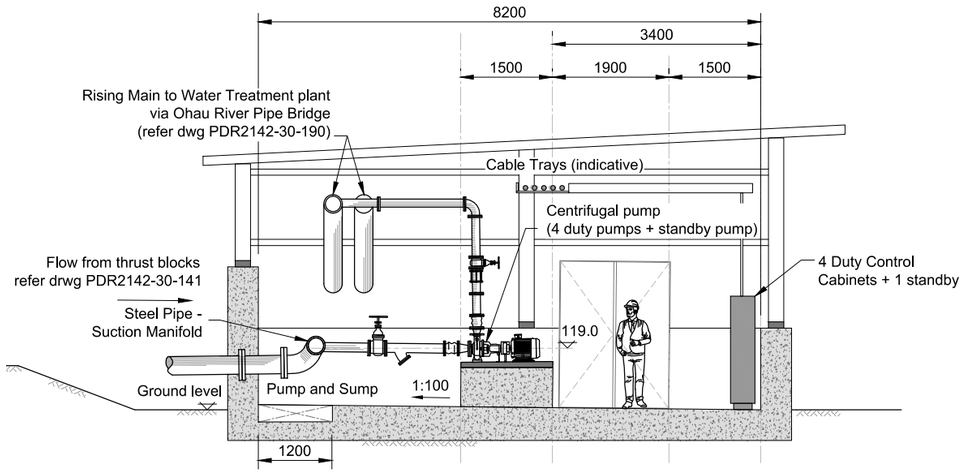
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Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
info@damwatch.co.nz
+64 4 381 1300

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PLAN 1:100 (-)



ELEVATION 1 (-) 1:100

Notes:

1. All levels are to NZVD2016 mean sea level.
2. All units are in millimeters unless stated otherwise.
3. For location plan, refer drawing PDR2145-30-104.

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issued for Comments	FS	JE	S.M.	16/03/23

Graphic Scales 1:100 0 1 2 3 4 5 m

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

DRAWOFF PUMPING STATION
GENERAL ARRANGEMENT

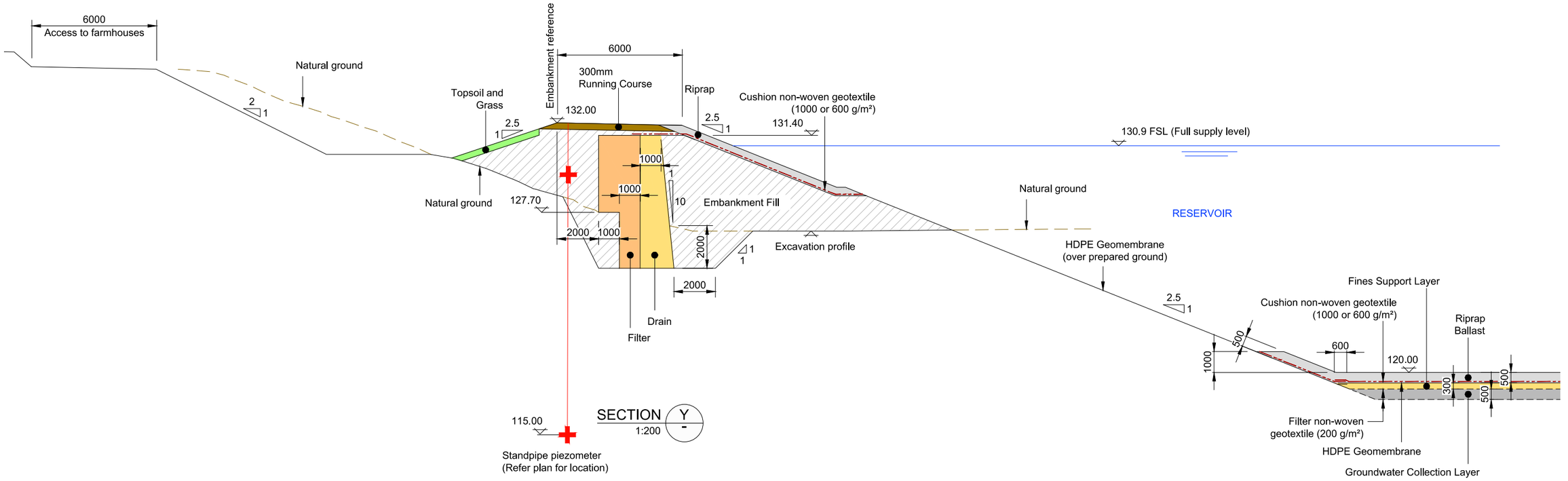
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info@damwatch.co.nz
+64 4 381 1300

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Notes Keys and References



Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	ISSUED FOR COMMENT	RL	J.E.	S.M.	16/03/23

Graphic Scales
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Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

RESERVOIR EMBANKMENT
SECTION Y

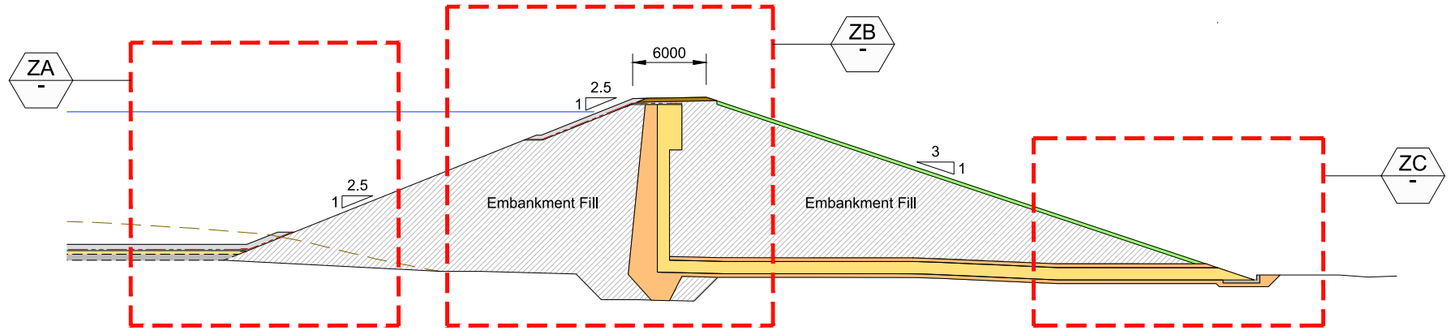
Scale	Project	Drawing Number	Revision
1:200	E2142A	PDR2142/30/130	R1

Original Sheet Size A3 (420x297)

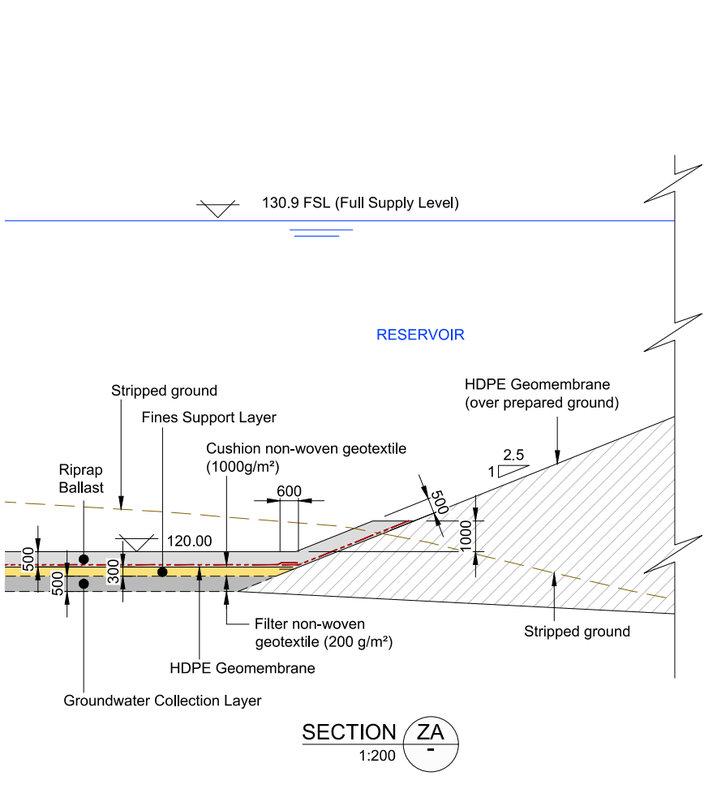
P. +64 4 381 1300
E. info@damwatch.co.nz
A. Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand

23 February 2023 3:19pm
200 mm
100
50
10 mm
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C:\12d\S\data\dmw-wlg-vms-004\E2142A Poads Road - Feasibility Design_280\6. CAD\DWG\PDR2142-30-130_131_160-165-Embankment_Spillway Sections1.dwg (30_130)

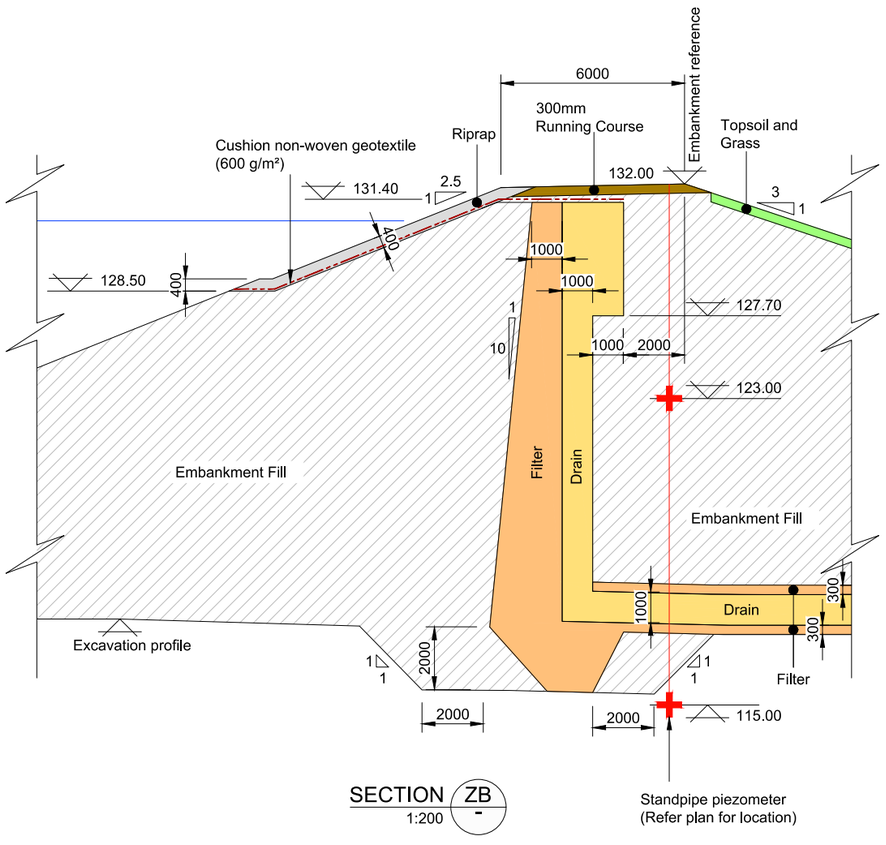
Notes Keys and References



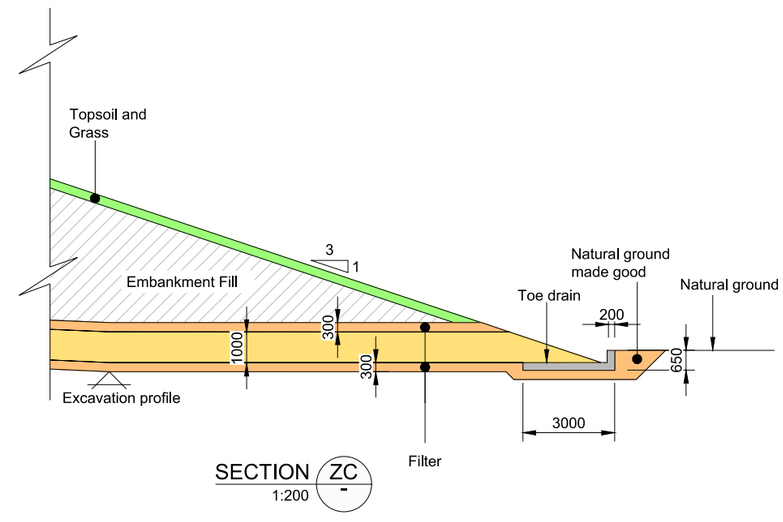
SECTION Z
1:500



SECTION ZA
1:200



SECTION ZB
1:200



SECTION ZC
1:200

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	ISSUED FOR COMMENT	R.L.	J.E.	S.M.	16/03/23

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

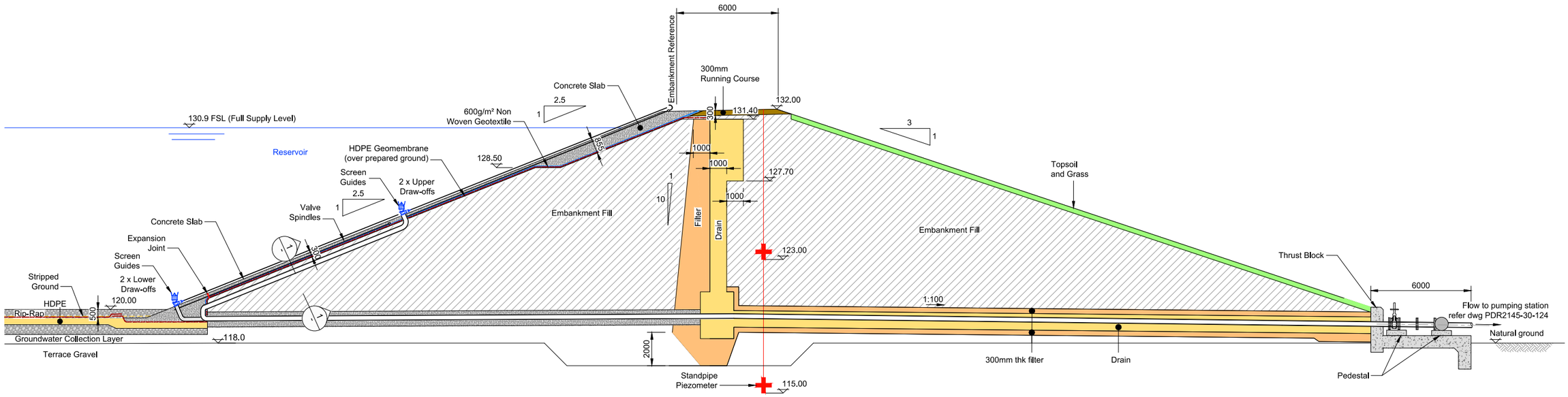
RESERVOIR EMBANKMENT
SECTIONS Z, ZA, ZB and ZC

Scale	Project	Drawing Number	Revision
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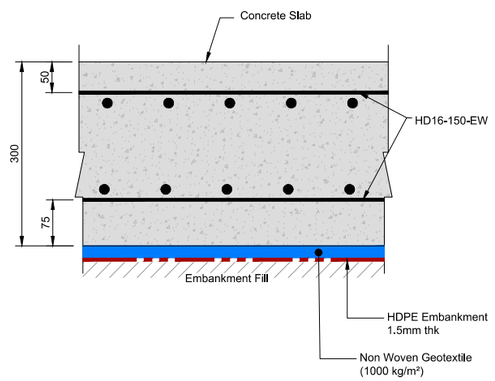
P +64 4 381 1300
E info@damwatch.co.nz
A Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand

23 February 2023 5:13pm
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200 mm
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0
10 mm
Graphic Scales
Original Sheet Size A3 (420x297)

Notes Keys and References



SECTION Z1
1:250



SECTION 1
1:10

Notes:

1. All units are in millimeters unless stated otherwise.
2. This drawing shall read in conjunction with other drawings.

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issue for Comment	F.S.	J.E.	S.M.	16/03/23

Graphic Scales
1:250 0 2 4 6 8 10 12 m
1:10 0 100 200 300 400 500 mm

Horowhenua DISTRICT COUNCIL
DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

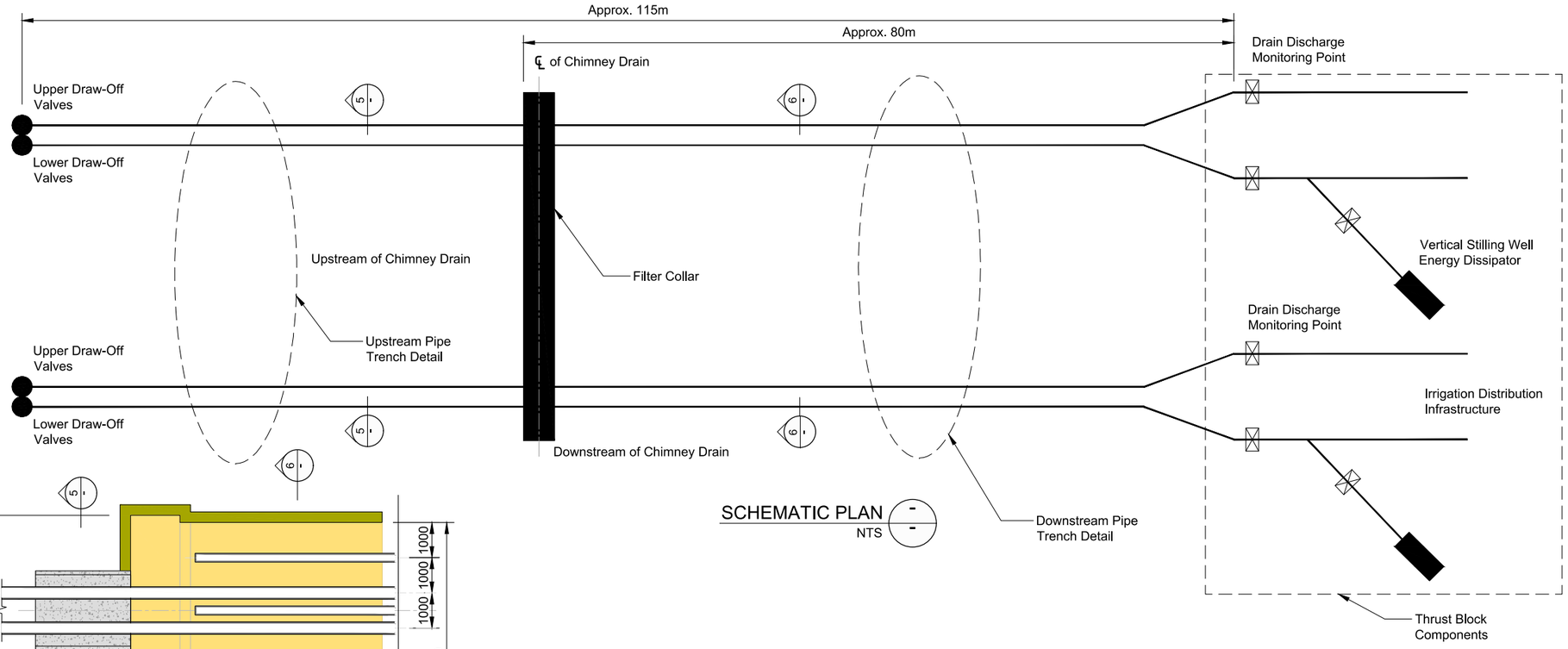
DRAWOFF ARRANGEMENT
SECTION Z1 GENERAL VIEW

Scale	Project	Drawing Number	Revision
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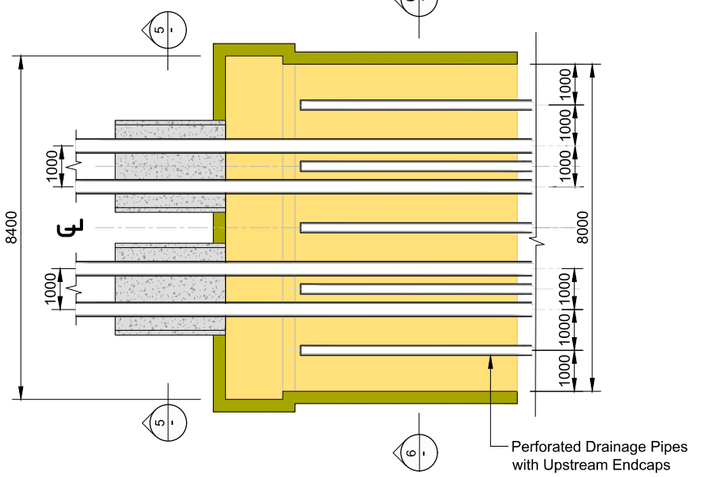
Original Sheet Size A3 (420x297)

Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
P. +64 4 381 1300
E. info@damwatch.co.nz

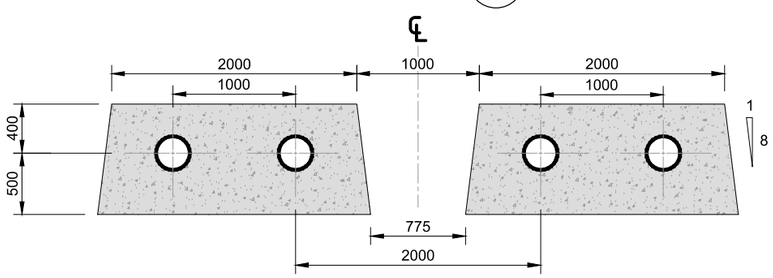
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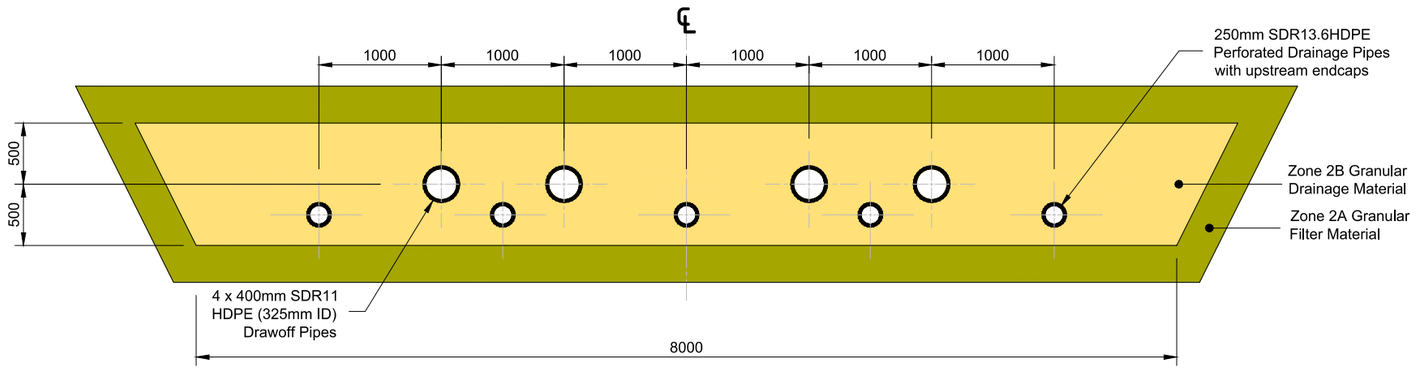
SCHEMATIC PLAN
NTS



FILTER COLLAR PLAN
1:150



UPSTREAM PIPE TRENCH DETAIL PLAN 5
1:50



DOWNSTREAM PIPE TRENCH DETAIL 6
1:50

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issue For Comment	FS	FZ	S.M.	16/03/23

Notes:

1. All dimensions shall be verified by the contractor before commencing work.
2. This drawing shall read in conjunction with other drawings.
3. For location plan, refer dwg PDR2142-30-104.

Graphic Scales 1:50 0 1 2 m

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

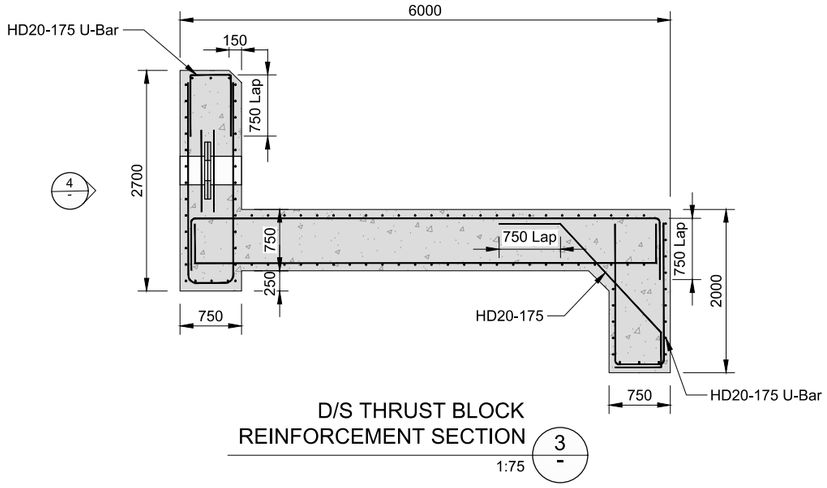
DRAWOFF SCHEMATIC AND PIPE SURROUND DETAILS

Scale	Project	Drawing Number	Revision
AS SHOWN	E2142A	PDR2142/30/143	R1

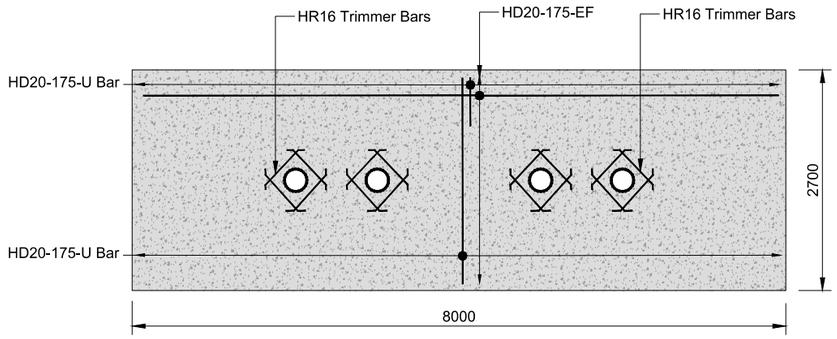
Original Sheet Size A3 (420x297)

Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
info@damwatch.co.nz
+64 4 381 1300

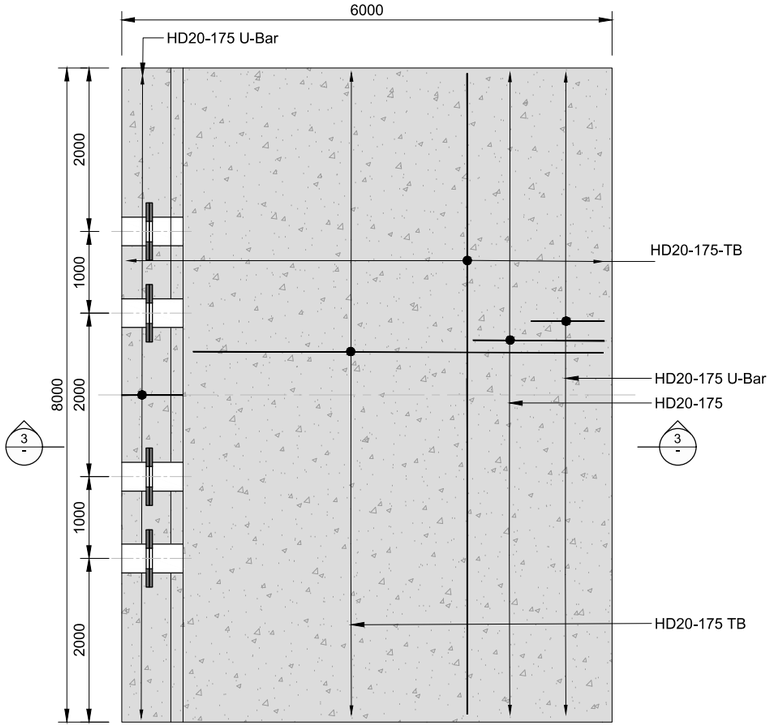
21 February 2023 5:12pm
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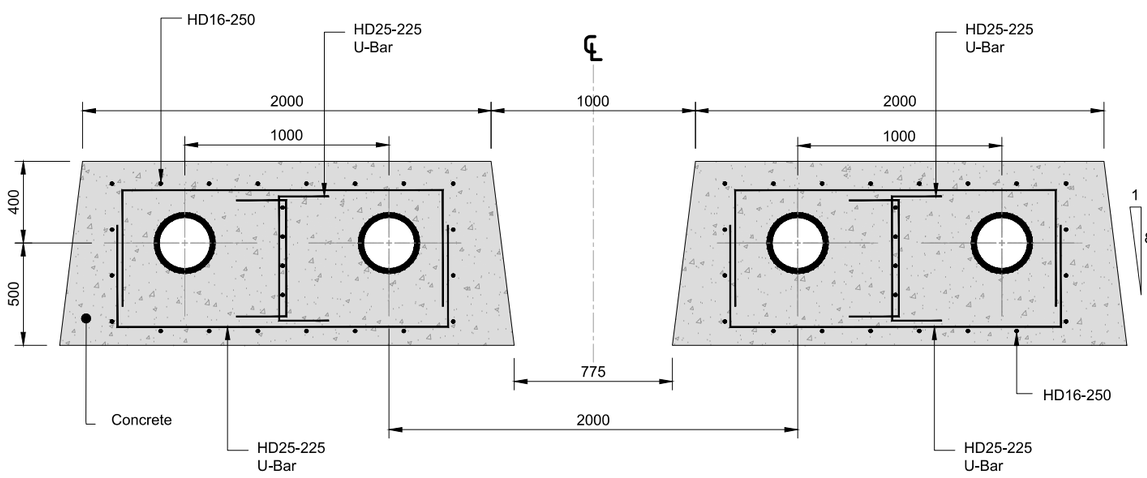
D/S THRUST BLOCK REINFORCEMENT SECTION 3 - 1:75



D/S THRUST BLOCK ELEVATION 4 - 1:75



D/S THRUST BLOCK REINFORCEMENT PLAN - - 1:75



UPSTREAM PIPE TRENCH REINFORCEMENT - - 1:30

Notes:

1. Characteristic compressive strength of concrete shall be 30MPa at 28 days.
2. Reinforcing in accordance with NZ codes and standards (NZS3101, 3109, ASNZS 4671, etc).
3. Minimum concrete cover to reinforcement bars shall be: 75mm cast against ground, 50mm typical.
4. All dimensions shall be verified by the contractor before commencing work.
5. This drawing shall read in conjunction with other drawings.
6. Drawings shall not be scaled for dimensions.
7. For location plan, refer dwg PDR2142-30-104.

HD12-150-BF
- EW - Each Way
- BF - Both Faces
- TB - Top Bottom
- Max. Spacing (mm)
- Nom Bar Dia. (mm)
- Bar Grade and Type

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issue For Comment	FS	FZ	S.M.	16/03/23

Graphic Scales
1:30 0 200 400 600 800 1000 1200 1400 mm
1:75 0 1 2 3 m

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

DRAWOFF GENERAL ARRANGEMENT
UPSTREAM PIPE SURROUND,DETAIL SECTIONS AND THRUST BLOCK REINFORCEMENT

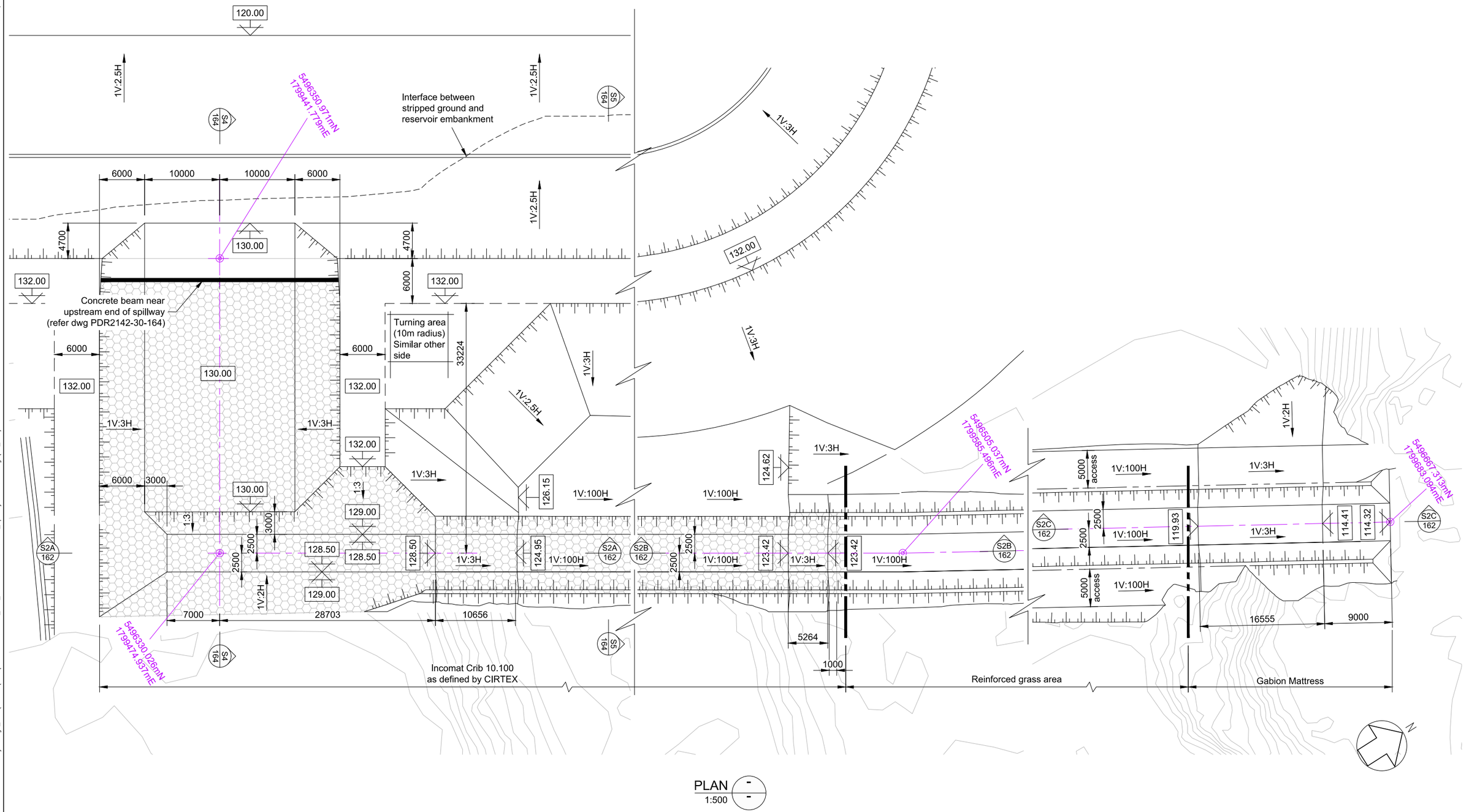
Scale	Project	Drawing Number	Revision
AS SHOWN	E2142A	PDR2142/30/144	R1

Original Sheet Size A3 (420x297)

Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
E info@damwatch.co.nz
P +64 4 381 1300

21 February 2023 5:15pm
200 mm
100
50
0
10 mm
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Notes Keys and References



PLAN
1:500

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	ISSUED FOR COMMENT	R.L.	JE	S.M.	16/03/23

Graphic Scales
1:500 0 4 8 12 16 20 24 m

Horowhenua DISTRICT COUNCIL
DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

SPILLWAY
PLAN ARRANGEMENT

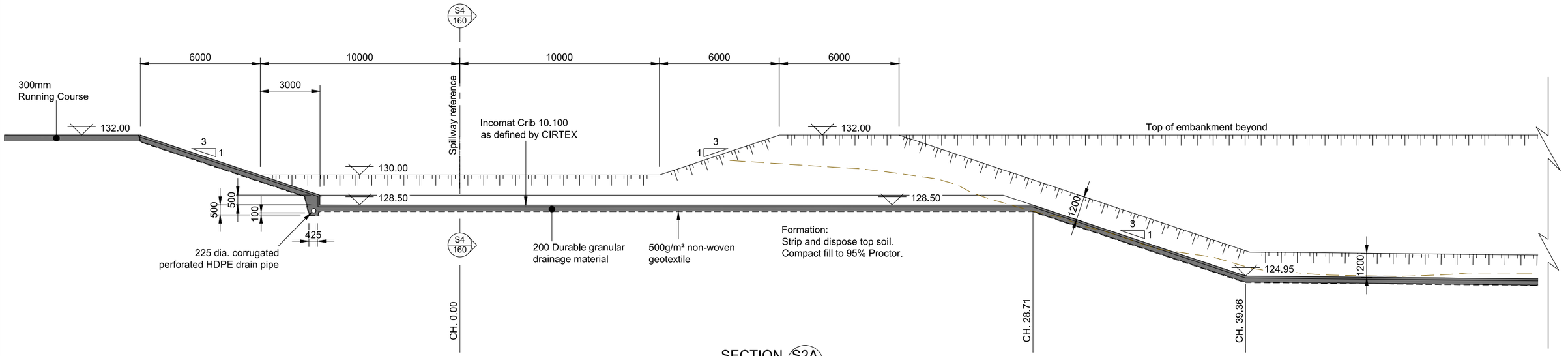
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Original Sheet Size A3 (420x297)

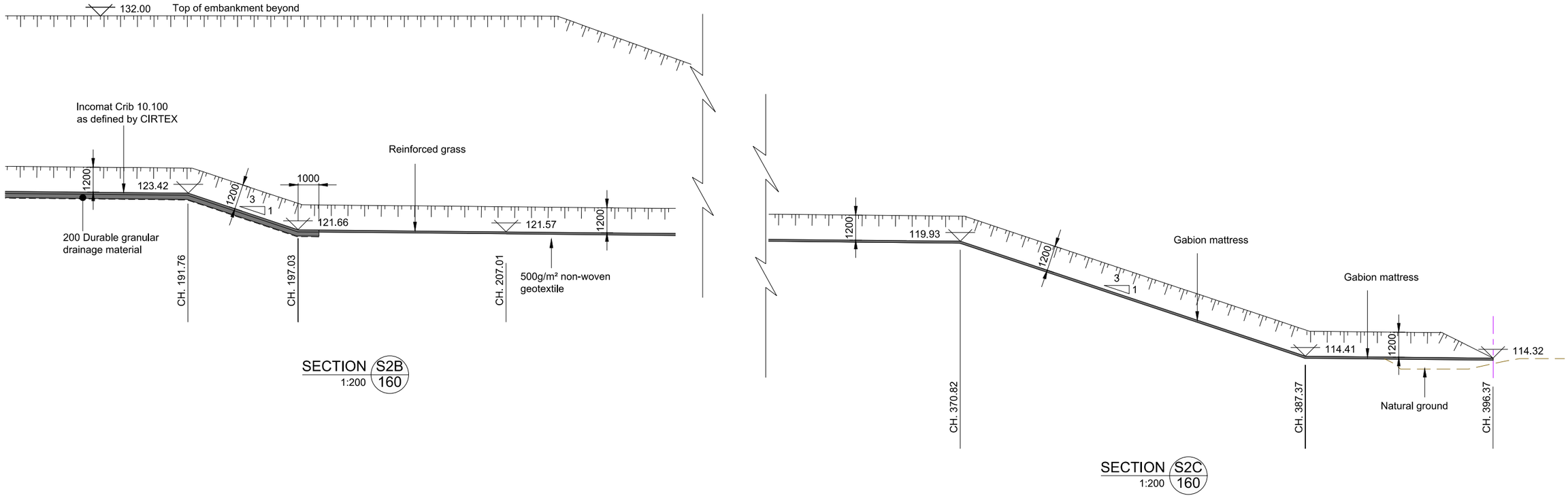
Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
info@damwatch.co.nz
+64 4 381 1300

23 February 2023 4:07pm
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Notes Keys and References



SECTION S2A
1:200 160



SECTION S2B
1:200 160

SECTION S2C
1:200 160

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	ISSUED FOR COMMENT	FS	JE	S.M.	16/03/23

Graphic Scales
1:200 0 2 4 6 8 10 m

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

SPILLWAY
SECTIONS S2A S2B and S2C

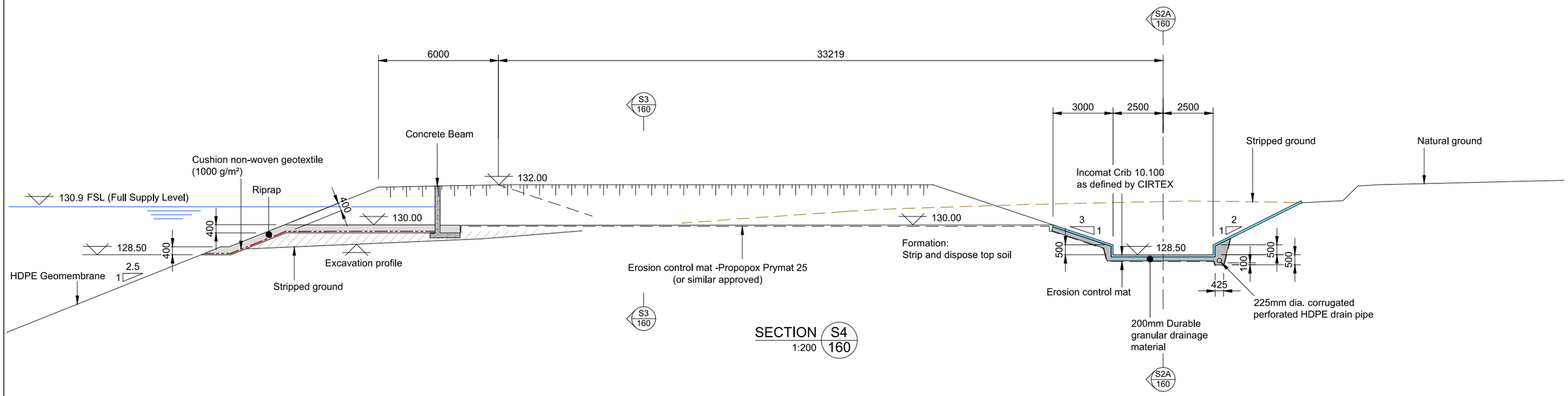
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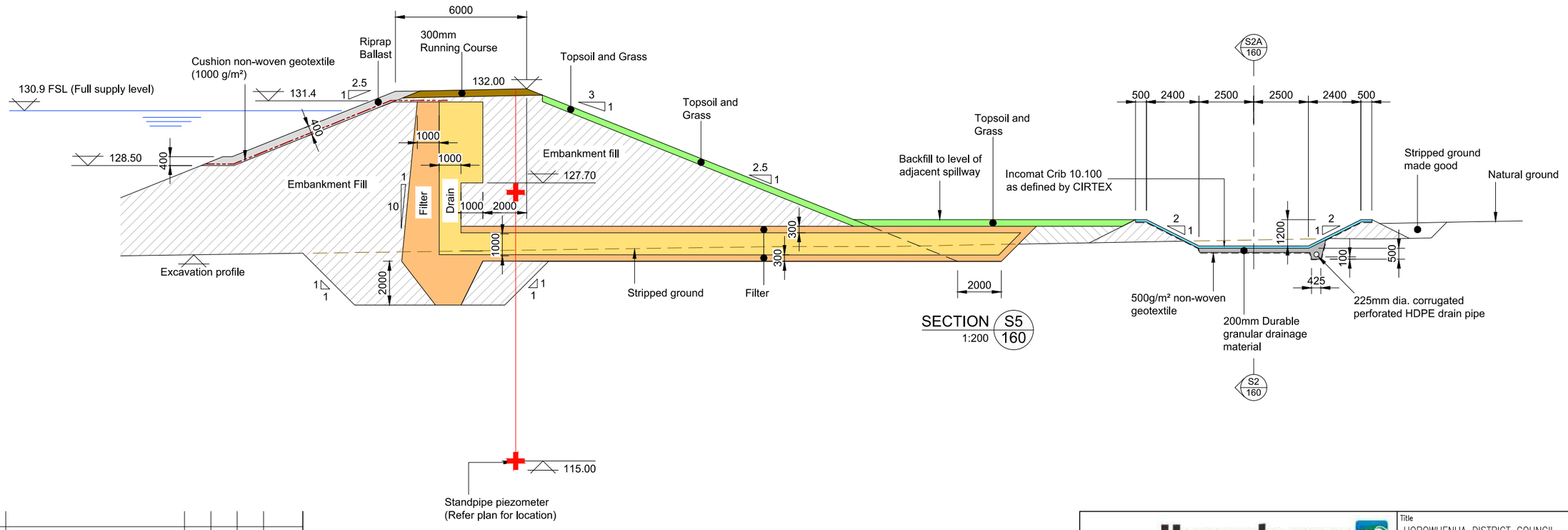
Original Sheet Size A3 (420x297)

P. +64 4 381 1300
E. info@damwatch.co.nz
A. Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand

23 February 2023 4:11pm
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Notes Keys and References





Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	ISSUED FOR COMMENT	RL	JE	S.M.	16/03/23

Graphic Scales 1:200 0 2 4 6 8 10 m

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

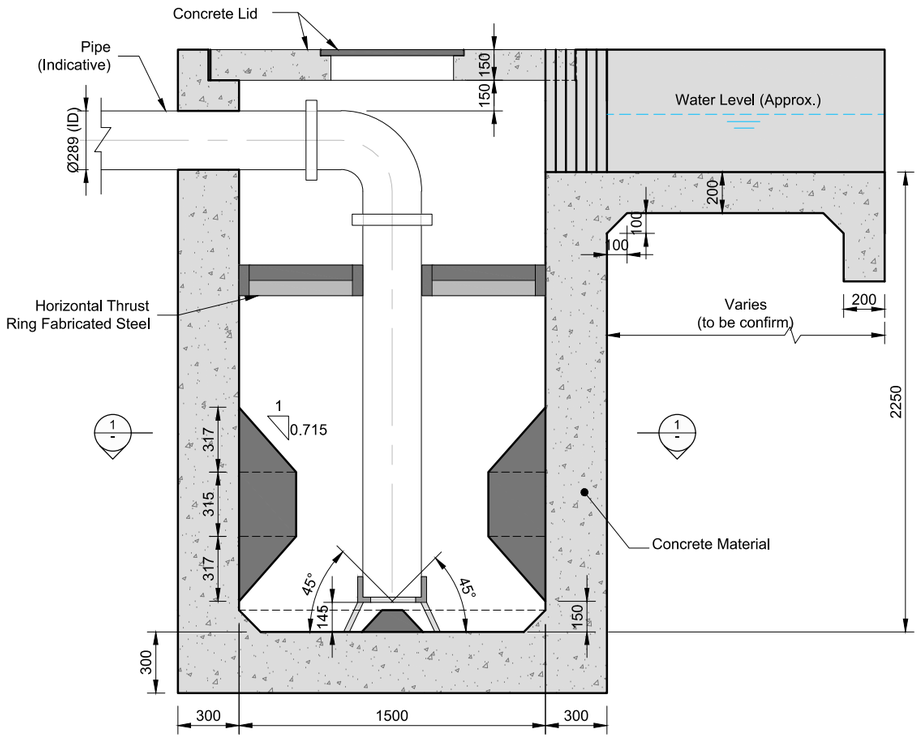
SPILLWAY
SECTIONS S4 AND S5

Scale	Project	Drawing Number	Revision
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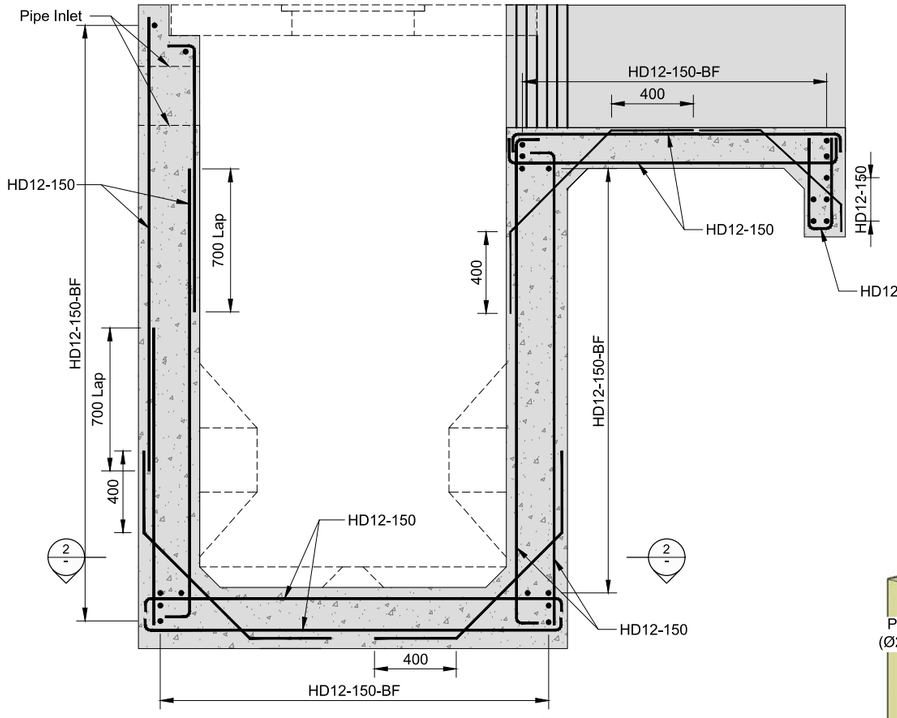
Original Sheet Size A3 (420x297)

Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
P +64 4 381 1300
E info@damwatch.co.nz

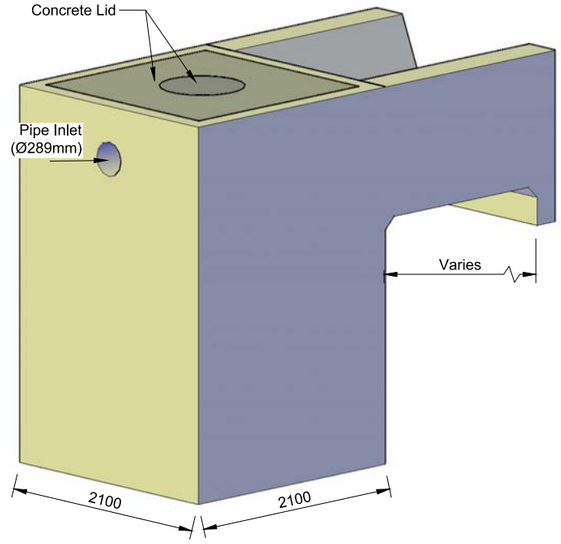
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10 mm
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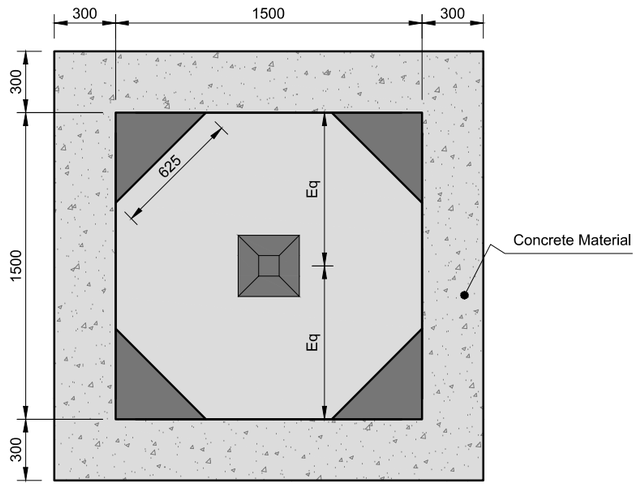
TYPICAL VERTICAL STILLING WELL
1:30



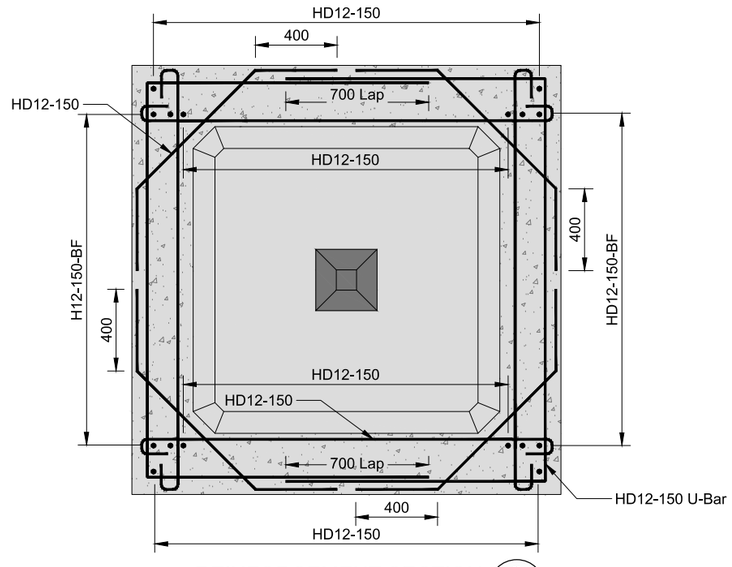
VERTICAL STILLING WELL REINFORCEMENT
1:30



ISOMETRIC VIEW
1:50



VERTICAL STILLING WELL SECTION
1:30



REINFORCEMENT SECTION
1:30

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issue For Comment	FS	FZ	S.M.	01/11/22

Notes:

1. Characteristic compressive strength of concrete shall be 30MPa at 28 days.
2. Reinforcing in accordance with NZ codes and standards (NZS3101, 3109, ASNZS 4671, etc.).
3. Minimum concrete cover to reinforcement bars shall be: 75 mm cast against ground, 50 mm typical.
4. All dimensions shall be verified by the contractor before commencing work.
5. This drawing shall read in conjunction with other drawings.
6. Drawings shall not be scaled for dimensions.
7. Steel braces and legs to fix the pipe to the vertical stilling well are to be defined in design stage.
8. Reinforcement specific details for concrete fillets, pedestal and lid will be provided in design stage as well as the additional reinforcement around openings.
9. For location plan, refer to dwg PDR2142-30-104.

HD12-150-BF
- EW - Each Way
- BF - Both Faces
- TB - Top Bottom
- Max. Spacing (mm)
- Nom Bar Dia. (mm)
- Bar Grade and Type

Graphic Scales
1:30 0 200 400 600 800 1000 1200 1400 mm
1:50 0 1 2 m

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

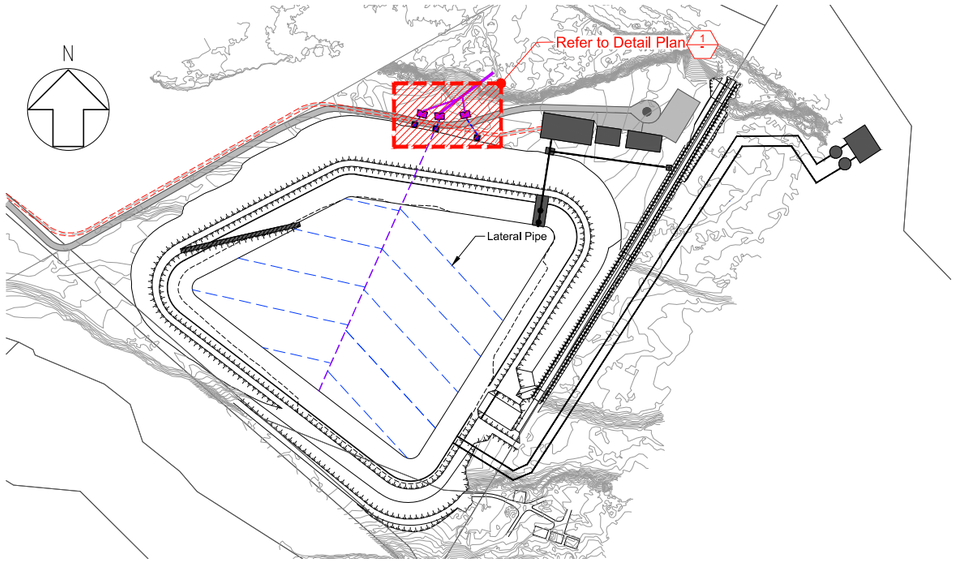
VERTICAL STILLING WELL
PLAN, SECTION AND REINFORCEMENT DETAILS

Scale	Project	Drawing Number	Revision
AS SHOWN	E2142A	PDR2142/30/171	R1

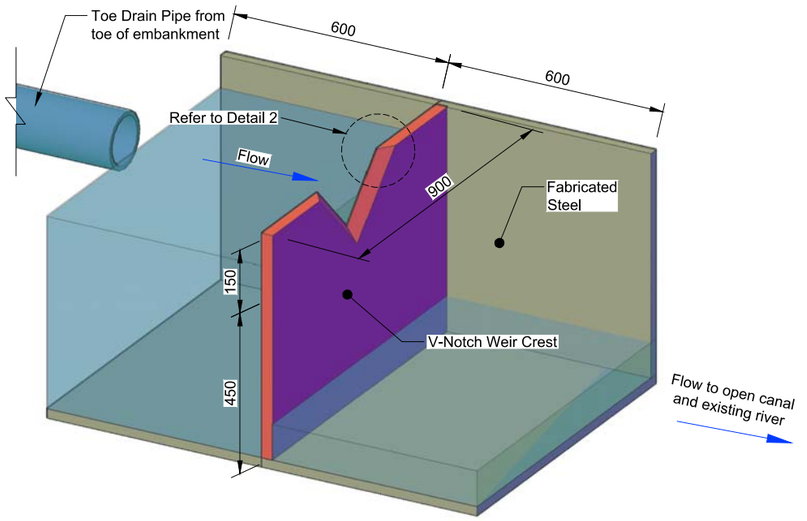
Original Sheet Size A3 (420x297)

Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
info@damwatch.co.nz
+64 4 381 1300

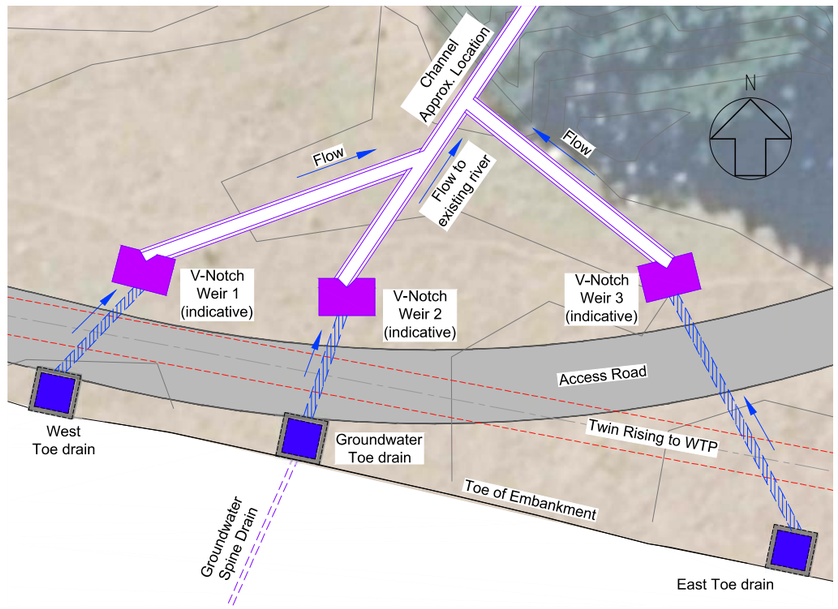
21 February 2023 5:20pm
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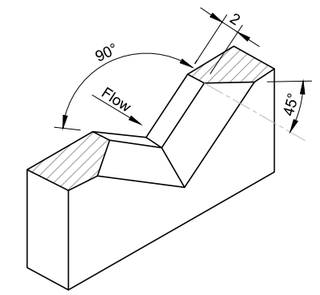
LOCATION PLAN
1:6000



ISOMETRIC VIEW
1:15



DETAIL PLAN 1
1:500



WEIR PLATE VERTEX DETAIL 2
NTS

Notes:

1. All co-ordinates are to NZTM and levels are to NZVD2016 mean sea level.
2. All units are in millimeters unless stated otherwise.
3. Contours from LINZ LiDAR survey 2016.

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issued for Comments	FS	JE	S.M.	16/03/23

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

WEIR V-NOTCH CREST
PLAN AND TYPICAL ISOMETRIC VIEW

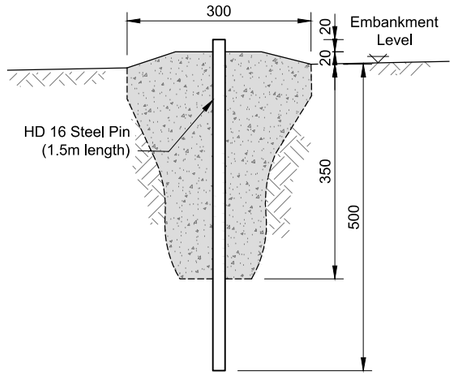
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AS SHOWN	E2142A	PDR2142/30/180	R1

Graphic Scales

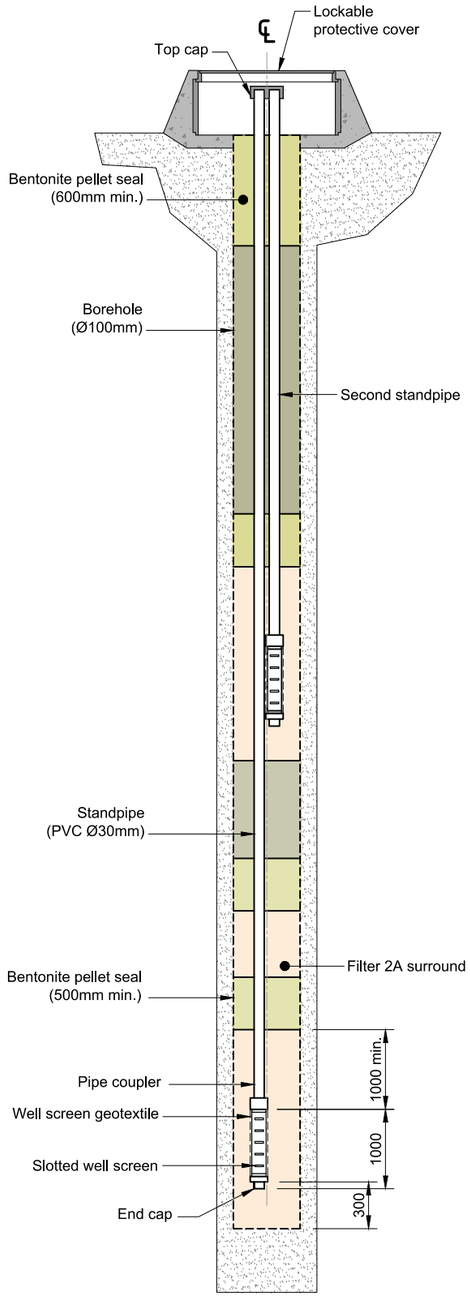
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Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
info@damwatch.co.nz
+64 4 381 1300

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TYPICAL SETTLEMENT MONITORING
POINT DETAIL SECTION
1:10



GENERAL ARRANGEMENT OF MONITORING WELL
NTS

Notes:

1. All coordinates are in NZTM and levels are to NZVD2016 mean sea level.
2. All dimensions are in millimeters unless stated otherwise.

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issued for Comments	FS	JE	S.M.	16/03/23

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

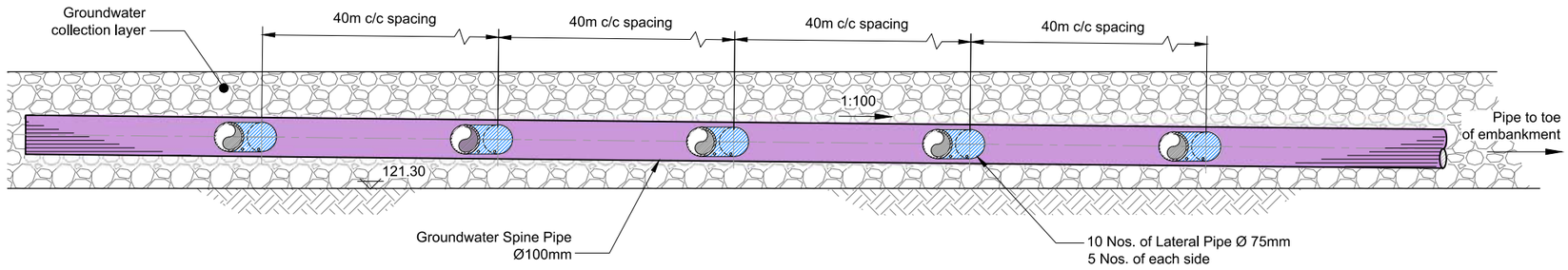
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HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

SETTLEMENT MONITORING POINT AND WELL TYPICAL SECTION AND DETAILS

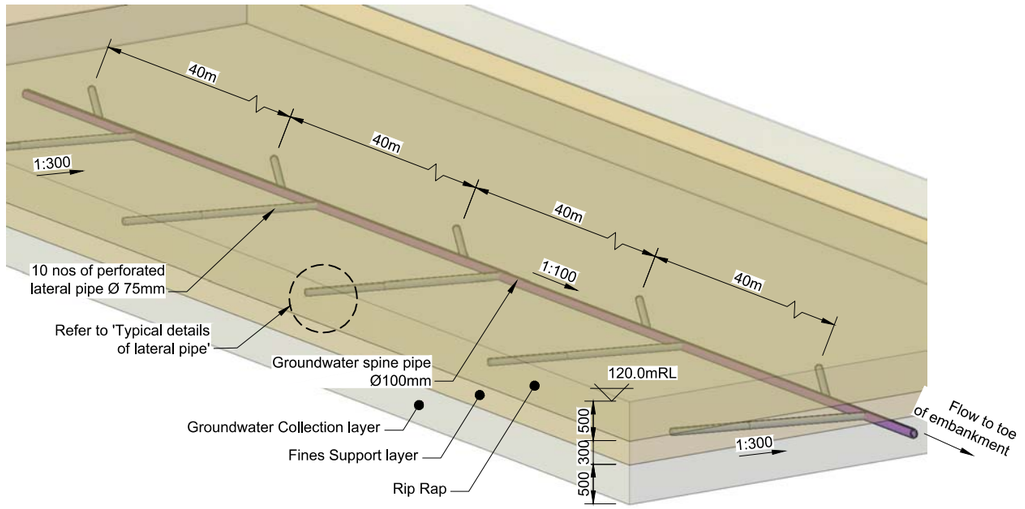
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AS SHOWN	E2142A	PDR2142/30/181	R1

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info@damwatch.co.nz
+64 4 381 1300

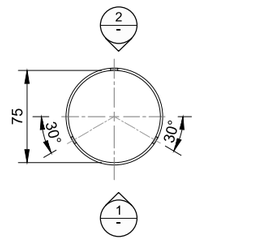
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Graphic Scales
Original Sheet Size A3 (420x297)



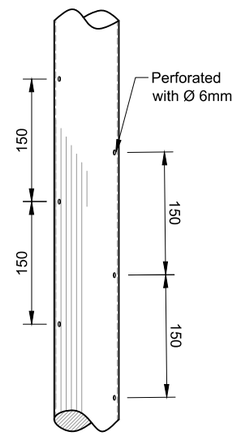
LONGITUDINAL SECTION 1:15



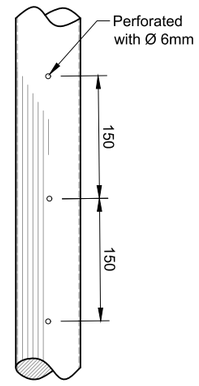
ISOMETRIC VIEW OF GROUND WATER DRAINAGE PIPE ARRANGEMENT
NTS



TYPICAL SECTION 1:5



BOTTOM VIEW 1
1:7.5



TOP VIEW 2
1:7.5

TYPICAL DETAILS OF LATERAL PIPE

Notes:

1. All co-ordinates are to NZTM and levels are to NZVD2016 mean sea level.
2. All dimensions are in millimeters unless stated otherwise.
3. This drawing shall read in conjunction to other drawings.
4. For longitudinal section location, refer to dwg PDR2142-30-104.

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issued for Comments	FS	JE	S.M.	16/03/23

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

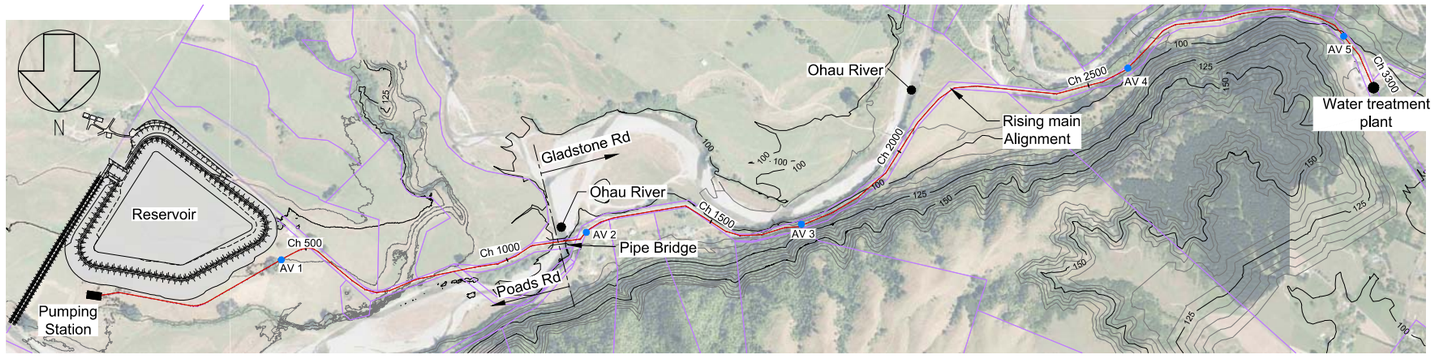
GROUNDWATER COLLECTION AND LATERAL PIPES SECTION AND TYPICAL DETAILS

Scale	Project	Drawing Number	Revision
AS SHOWN	E2142A	PDR2142/30/182	R1

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P. +64 4 381 1300
E. info@damwatch.co.nz

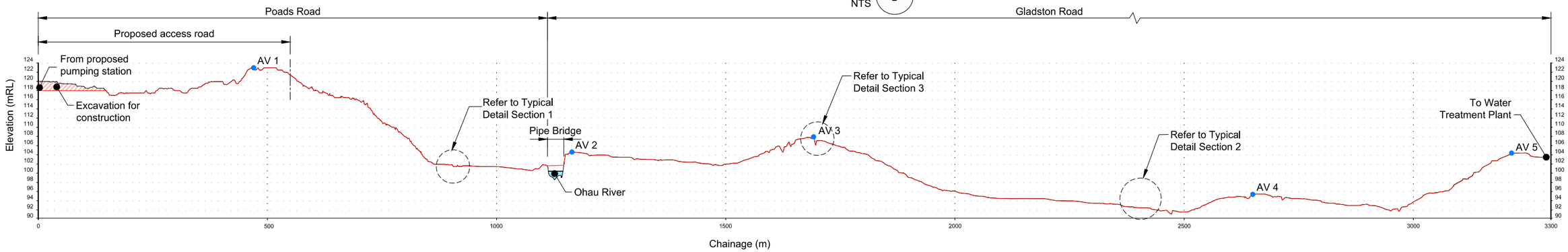
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Graphic Scales
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Notes Keys and References



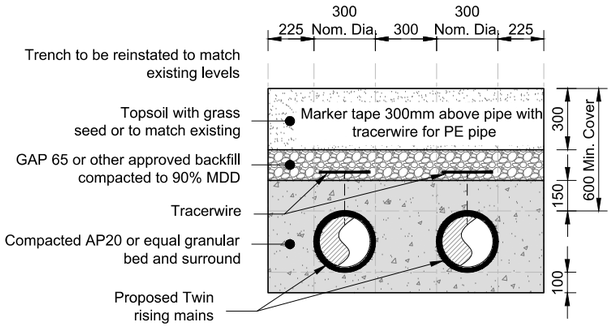
KEY LOCATION PLAN

NTS



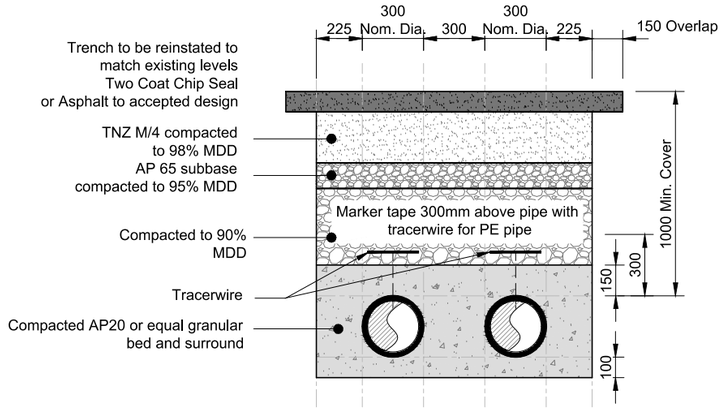
LONGITUDINAL SECTION OF RISING MAIN

NTS



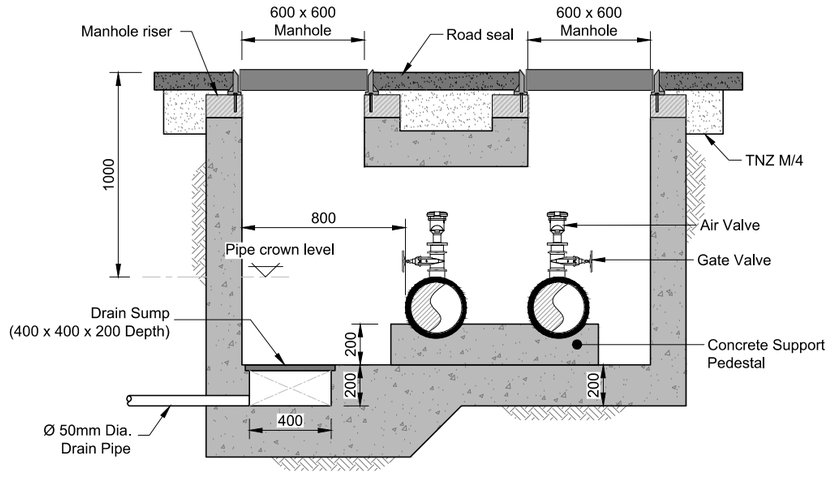
TYPICAL SECTION FOR NON-TRAFFICABLE TRENCH 1

1:30



TYPICAL DETAIL SECTION FOR CHIPSEAL CARRIAGEWAY 2

1:30



AIR VALVE CHAMBER IN ROAD DETAIL SECTION 3

1:30

Notes:

1. All co-ordinates are to NZTM and levels are to NZVD2016 mean sea level.
2. All units are in millimeters unless stated otherwise.
3. All HDPE pipes shall be PE100 and sections shall be butt fusion welded.
4. HDPE pipes shall be pressure tested and approved by the engineer in accordance with the specification before concrete encasement or backfilling.
5. Any steel and ductile iron pipework, fittings and valves shall be manufactured, supplied, installed and tested in accordance with Watercare Services Ltd "Material Supply Standard" version 1.8 2020 or later.

Legend:

- Rising main profile
- Existing major profile (5m contour)
- Existing minor profile (0.5m contour)
- Existing Parcel
- AV*xx* Air Valve (at high point)

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issued for Comments	FS	JE	S.M.	16/03/23

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

RISING MAINS
TYPICAL SECTION AND DETAILS

Scale	Project	Drawing Number	Revision
AS SHOWN	E2142A	PDR2142/30/190	R1

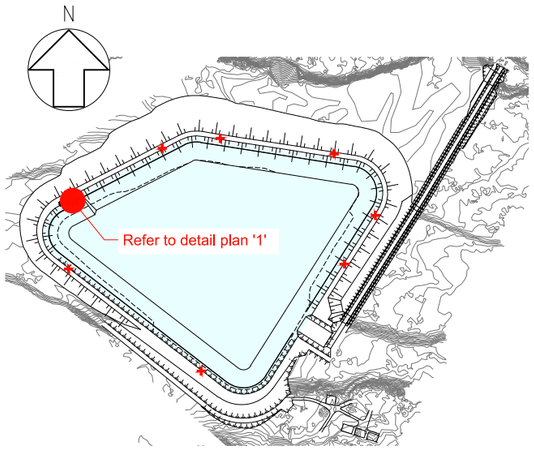
Graphic Scales

Original Sheet Size A3 (420x297)

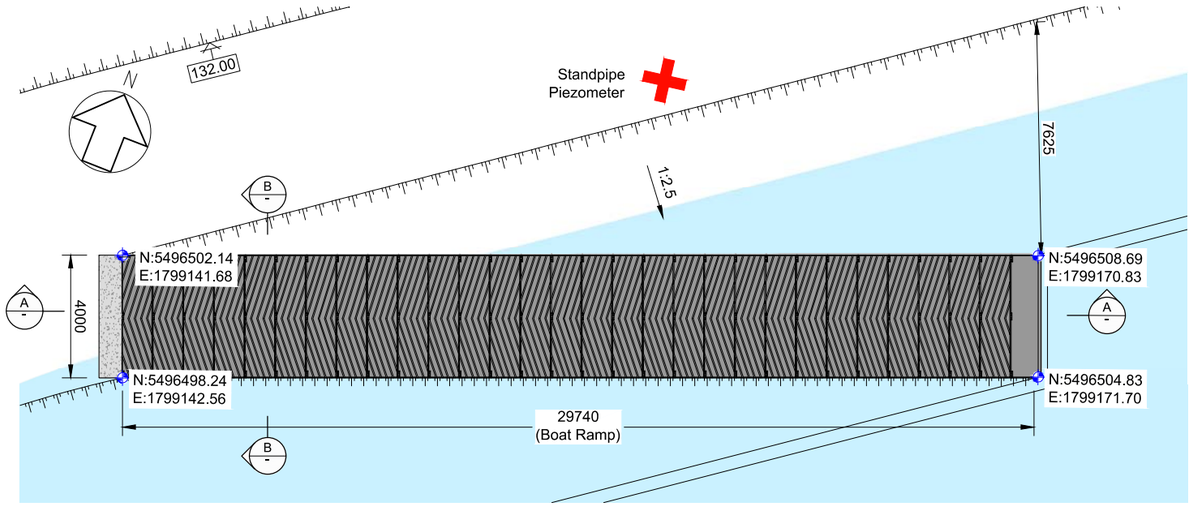
Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1543, Wellington 6140, New Zealand
info@damwatch.co.nz
+64 4 381 1300

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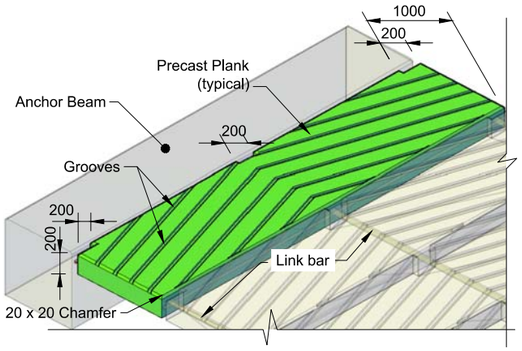
Notes Keys and References



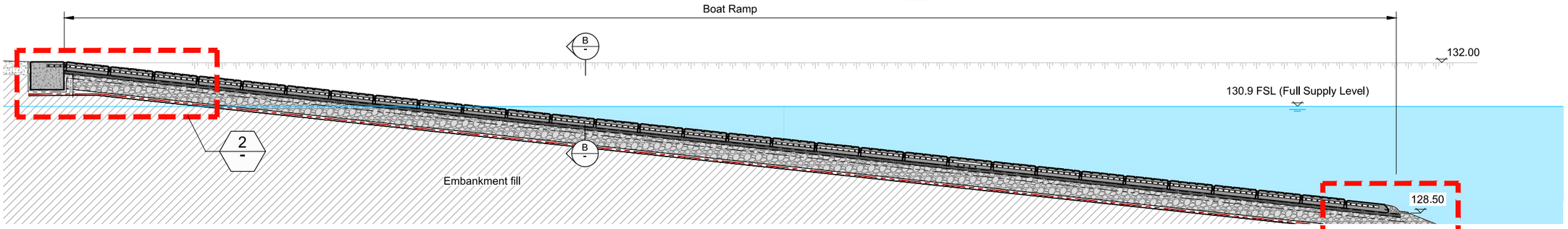
KEY PLAN
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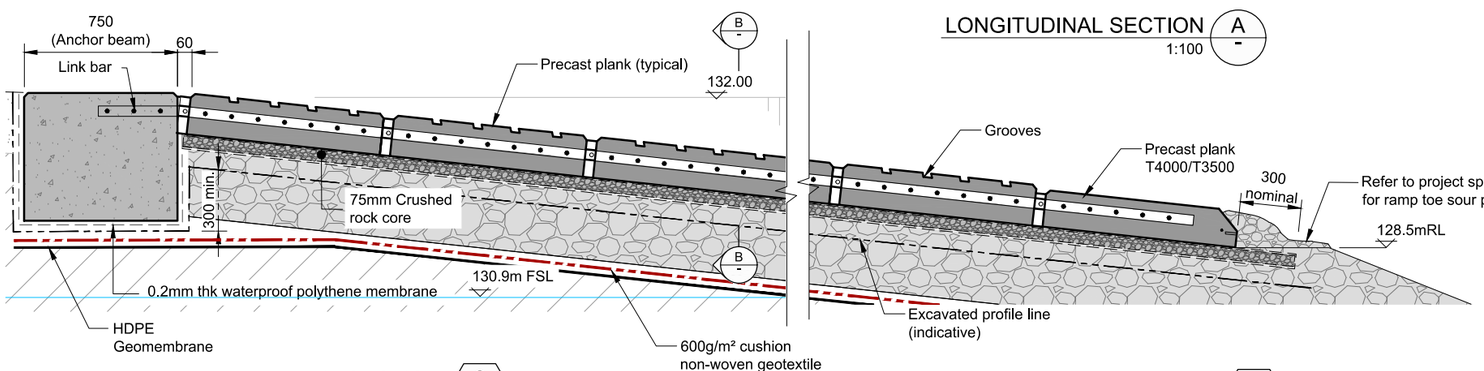
BOAT RAMP DETAIL PLAN 1
1:200



ISOMETRIC VIEW
1:50

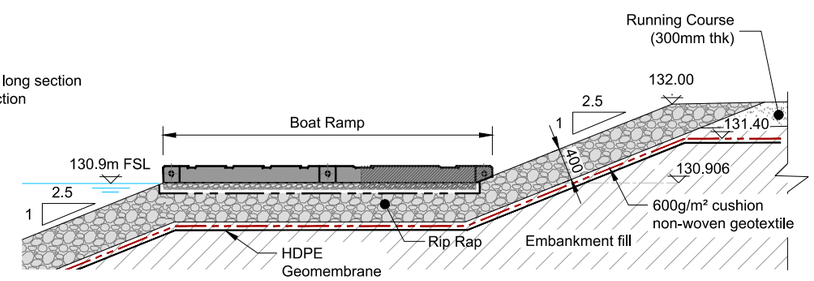


LONGITUDINAL SECTION A
1:100



DETAIL SECTION 2
1:30

DETAIL SECTION 3
1:30



TYPICAL SECTION B
1:75

Notes:

1. All co-ordinates are in NZTM and levels are to NZVD2016 mean sea level.
2. All dimensions are in millimeters unless stated otherwise.
3. For general layout plan refer to drawing no. PDR2141-30-104.
4. This drawing shall read in conjunction with other drawings.

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issue For Comment	FS	JE	S.M.	16/03/23

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

BOAT RAMP LOCATION PLAN, SECTION AND TYPICAL DETAILS

Scale	Project	Drawing Number	Revision
AS SHOWN	E2142A	PDR2142/30/220	R1

Graphic Scales

Original Sheet Size A3 (420x297)

Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
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+64 4 381 1300

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General

Drawings and Specifications

- The drawings shall be read in conjunction with all the other drawings and specifications and with other written instructions as may be issued during the contract.
- Drawings shall not be scaled for dimensions.
- All arrangments and dimensions shall be verified by contractor on site. Any discrepancy shall be referred to the engineer before proceeding with the works on site.
- The contractor shall verity all dimensions relating to existing work or items supplied by others on site.
- The contractor shall be responsible for their correctness, any differences found shall be notified to the engineer.
- Should the contractor at any time identify an error in a drawing or specification, discrepancy or variation between dimensions and measurement at site or lack of dimensions or any other information, the contractor shall notify the engineer and shall not proceed before clarification is received.
- The contractor shall raise a request for information (RFI) requesting the engineer for an additional/missing details that are required to undertake the construction of the works as per standard engineering practice.
- In the event of confilct between information shown on the drawings and the specifications, the more stringent shall take precedence.

Coordinates and Datum

- All Coordinates are in NZTM and elevation levels are in NZVD2016 mean sea level .

Codes and Standards

- Refer to the specification for all codes and standards relevant to the works.

Method Statement

- The contractor shall submit to the engineer its method statement for approval prior to the excavation of works on site.

Excavation and Fill

- All earthworks, excavation and fill, shall be in accordance with the earthworks specifications.

Structural

Concrete Works

- All concrete shall be installed in accordance with concrete specification.
- Mixing, transporting pouring and curing shall be in accordance with the concrete specification.
- Dimensions shown on the drawings are the theoretical. The contractor shall make allowance for fabrication tolerances and installation on site.
- Concrete strength shall be f'c=30MPa at 28 days unless noted otherwise.
- Minimum cover to reinforcement shall be:
  - 75mm Cast against ground
  - 50mm typical unless noted otherwise
- Exposure classification: B2
- Blinding concrete (50mm) shall be provided where lining/subgrade does not adequately support rebar during construction.
- Codes and standards relevant to works, refer to the specification.

Reinforcement

- The reinforcement shall be installed in accordance with the concrete specification.

Reinforcement Abbrevations:

HD12-150-BF

- EW - Each Way
- BF - Both Faces
- TB - Top Bottom

Max. Spacing (mm)

Nom Bar Dia. (mm)

Bar Grade and Type

Terminology	Type
R	Plain bars grade 300 to NZS3679.1 (300MPa)
M	Mesh to AS/NZS 4671 grade 500 (500MPa)
D	Deformed bars grade 300E to AS/NZS 4671 (300MPa)
HD	Deformed bars grade 500E to AS/NZS 4671 (500MPa)
HR	Plain bars grade 500E to AS/NZS 4671 (500MPa)
RB	Reidbar grade 500E to AS/NZS 4671 (500MPa)

- Maintain cover to reinforcement at chamfers, drip grooves, etc.
- Reinforcement is presented diagrammatically on the drawings and not neccessarily in the projection.
- All reinforcement shall be minimum grade fy = 500N/mm² U.N.O.

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issue For Comment	FS	JE	S.M.	16/03/23

Graphic Scales

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

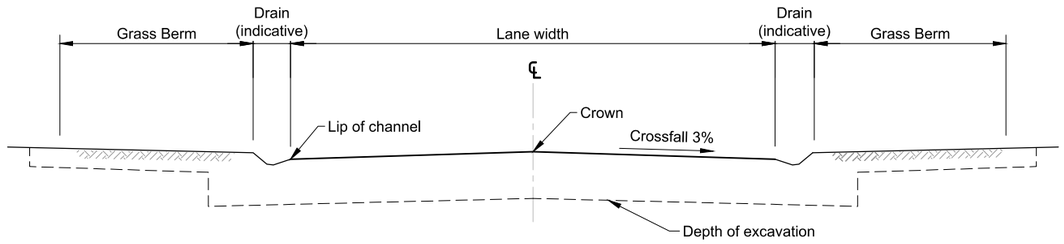
STANDARD DRAWING NOTES

Scale	Project	Drawing Number	Revision
NTS	E2142A	PDR2142/30/301	R1

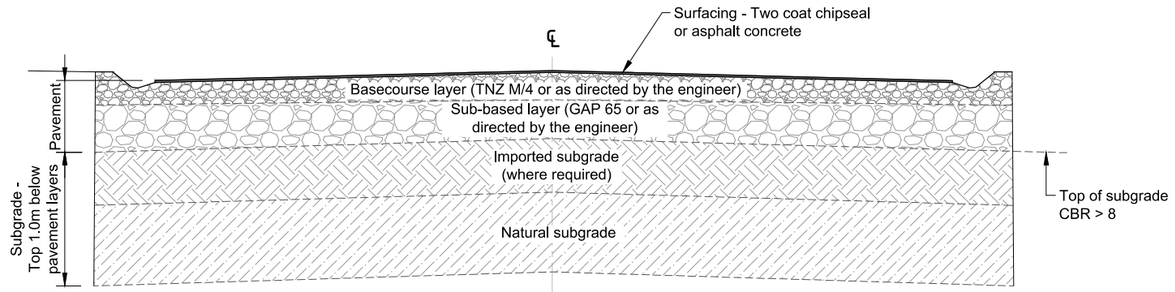
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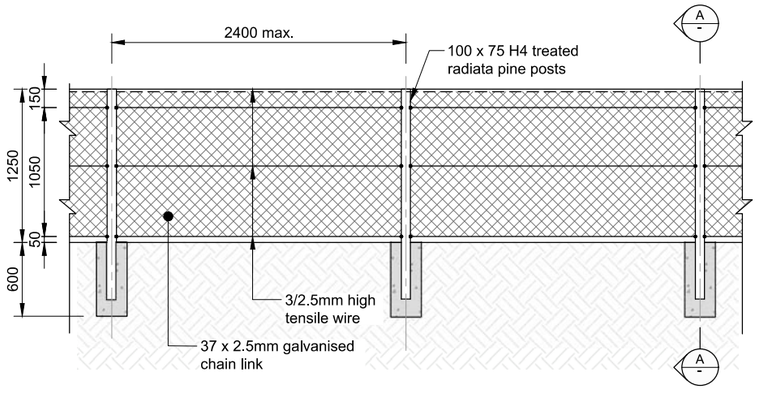
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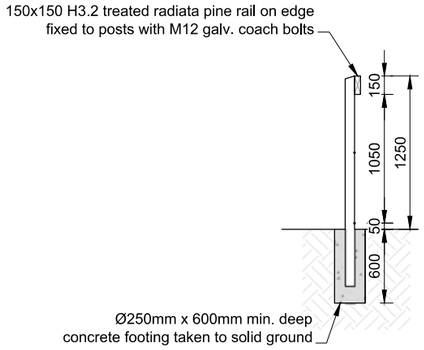
TYPICAL SECTION OF ROAD WIDTH
NTS



TYPICAL SECTION OF ROAD WIDTH FORMATION
NTS



TYPICAL WIRE MESH FENCE
1:50



SECTION A
1:50

Notes

1. All dimensions are in millimeters unless stated otherwise.
2. Advisory speed limit to be agreed and approved by the engineer.
3. Refer to MOTSAM for all signs and road marking layout.
4. Alternative profile and/or materials may be used where approved by the engineer.
5. Standard road formations and details are sourced from Horowhenua District Council.
6. Wire mesh fence standard referenced on NZ standards.

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issue For Comment	FS	J.E.	S.M.	16/03/23

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

STANDARD DETAILS

Scale AS SHOWN | Project E2142A | Drawing Number PDR2142/30/302 | Revision R1

Graphic Scales

Original Sheet Size A3 (420x297)

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info@damwatch.co.nz
+64 4 381 1300

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Appendix B Potential Impact Category Assessment

Memo

To:	Jeremey Eldridge, Danny Bardsley (Damwatch)
From:	Bill Veale, Grant Webby, Cristian Hadad (Damwatch)
CC:	File.
Date:	17/03/2023
Subject	**Potential Impact Classification for proposed Poads Road Water Storage Reservoir**

This memorandum sets out the Potential Impact Classification for the proposed Poads Road Water Storage Reservoir, to be constructed about 7 km south-east of Levin.

1. Background

The New Zealand Society on Large Dams published the *New Zealand Dam Safety Guidelines*[1] in May 2015. These guidelines provide recommended practices for the investigation, design, construction, and long-term maintenance and operation of large dams.

The *New Zealand Dam Safety Guidelines* include a dam classification system that categorises large dams as having a "Low", "Medium" or "High" Potential Impact Classification (PIC). The PIC reflects the potential impact a hypothetical dam failure could have on downstream people, property, infrastructure and the environment.

A dam's PIC is primarily used to determine the design standards and the level of rigour that should be applied to construction, monitoring and operation of the dam throughout its life. The principle is that a dam with a High PIC, for which failure would have a major impact on downstream people, property and the environment, should be designed, constructed and managed to a higher standard than a Low or Medium PIC dam for which failure would have a lesser downstream impact. Internationally, this is a well-established practice for dams which is accepted by both the dam engineering industry and dam safety authorities.

It should be noted that the PIC of a dam has no correlation with the probability of the dam failing or experiencing a dam safety incident.

2. PIC Assessment Methodology

The methodology to evaluate the PIC for a dam is outlined in the *New Zealand Dam Safety Guidelines* and is summarised briefly as follows:

- *Dam-break flood hazard assessment*: Evaluate the rate of release of the reservoir storage for hypothetical dam failure scenario(s) and estimate the resulting downstream flood hazard due to propagation of the dam-break flood wave.
- *Consequence assessment*: Using the results from the dam-break flood hazard assessment, assess the impact of a hypothetical dam failure on downstream people, property, cultural sites, infrastructure and the environment.

1 NZSOLD. (2015). *New Zealand Dam Safety Guidelines*. New Zealand Society on Large Dams.

- *Assign Potential Impact Classification*: Assign a PIC to the dam using classification tables (described below) which correlate the estimated damage level with the estimated number of people at risk.

The *New Zealand Dam Safety Guidelines* provides classification tables to determine a dam's PIC. However, the Building (Dam Safety) Regulations, which were gazetted in May 2022 and which come into force in May 2024, provide updated tables to determine a dam's PIC. These latter tables are reproduced as Tables A1 and A2 in **Annex A** and have been used to determine the PIC of the Poads Road Water Storage Reservoir.

To determine the PIC for a dam requires consideration of the consequences of the hypothetical dam-break flood on:

I. Life safety
II. Community facilities
III. Cultural sites
IV. Critical or major infrastructure
V. Natural environment

Table A1 (Annex A) requires the assessor to assess the "damage level" to items II to V above, as either minimal, moderate, major or catastrophic. Table A2 is then used to determine the PIC, by aligning the highest assessed damage level with the life safety impact (item I above) which is measured primarily by the downstream Population at Risk (PAR) and Potential Loss of Life.

3. Level of Dam-break Flood Hazard and Consequence Assessment

The *New Zealand Dam Safety Guidelines* state that hypothetical dam-break flood hazard and consequence assessments (which are used to inform a dam's PIC) can be performed at varying levels of detail. The *New Zealand Dam Safety Guidelines* discuss three different levels of assessment which are summarised as follows:

- An initial assessment is based on readily available data and existing knowledge or from a qualitative estimation of the magnitude of a potential dam-break flood. It is likely to be conservative and may raise uncertainties that need to be resolved by an intermediate or comprehensive level of assessment.
- An intermediate assessment requires a more quantitative assessment in terms of the dam-break flood hazard and resulting downstream impact to people, property and the environment.
- A comprehensive assessment is typically required for dams that would have considerable downstream impact in a hypothetical dam failure event, or if there are unresolved uncertainties from an initial or intermediate assessment. This level of assessment requires detailed computational hydraulic modelling of the dam-break flood and detailed data gathering to determine the downstream impact to people, property and environment.

The level of PIC assessment for the proposed Poads Road Water Storage Reservoir is at an "intermediate" level. The assessment is based on existing data and limited hydraulic calculations as outlined in the following sections of this letter.

4. Description of Proposed Poads Road Water Storage Reservoir

Preliminary details of the proposed Poads Road Water Storage Reservoir, described below, are based on the Damwatch (2023)[2] report "*Poads Road Water Storage Reservoir Feasibility Design Report*".

The proposed reservoir site is located off Poads Road near the Ohau River, about 7 km south-east of Levin. Figure 1 shows the layout of the proposed storage reservoir. The reservoir is an off-river storage facility, with water pumped into the reservoir through a pipeline system which extracts water from the Ohau River. Water will be abstracted from the reservoir via a pipeline to supply the Levin Water Treatment Plant.

Construction of the reservoir embankments is by excavation of in-situ granular material up to about 9 m below natural ground level. The excavated material will be used to form ring dam embankments which will be lined with an impermeable geomembrane liner.

Figure 2 provides a typical cross-section through the pond. The southern part of the reservoir is formed against existing high ground. The northern embankments are the highest and raised about 14 m above natural ground level.

The embankment height, volume and other parameters for the pre-feasibility design "Option C1" are summarised in Table 1.

Table 1 – Dam and reservoir parameters

Parameter	Value	Source
Levels (to NZVD2016 vertical datum)		
Embankment crest level	132.00 m RL	PDR2142/30/141 Damwatch (2023)
Full Supply Level	130.90 m RL	PDR2142/30/141 Damwatch (2023)
Lowest point on pond base	120.0 m RL	PDR2142/30/141 Damwatch (2023)
Ground elevation at embankment toe	118.0 m RL	At highest embankment on northern side
Embankment Height		
Embankment maximum height*	14.0 m	At highest point on northern side
Reservoir Area & Volume		
Reservoir area at embankment crest	87,500 m^2	Damwatch (2023)
Reservoir area at Full Supply Level	85,000 m^2	Damwatch (2023)
Reservoir area at pond base	50,200 m^2	Damwatch (2023)
Reservoir volume at Full Supply Level	740,000 m^3	Damwatch (2023)
Reservoir volume at embankment crest level	855,000 m^3	Damwatch (2023)

* For dams that are not across a stream (such as the proposed Poads Road Water Storage Reservoir), the height of a dam is defined in the Building Act 2004 as the vertical distance from the dam crest to the lowest ground elevation at the outside limit of the dam.

[2] Damwatch (2023). *Poads Road Water Storage Reservoir Feasibility Design Report*. Damwatch Engineering Limited. Ref: E2142A.

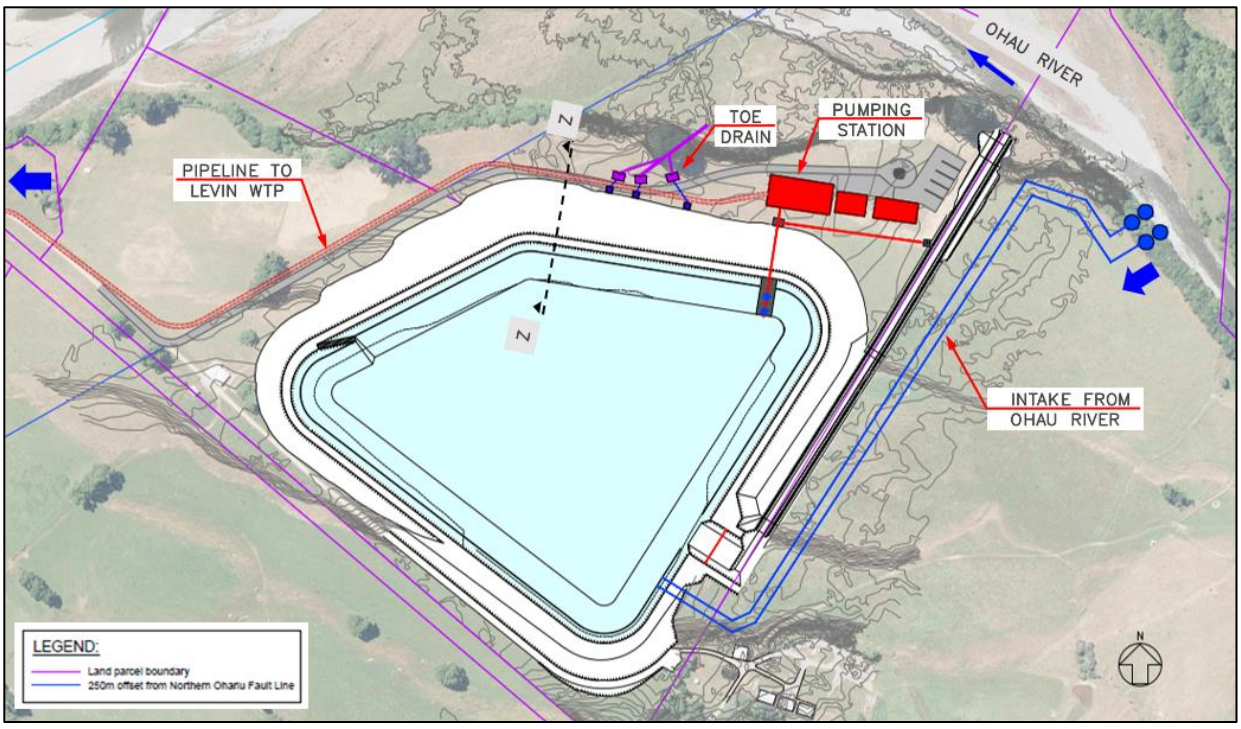


Figure 1 – Layout of proposed Poads Road Water Storage Reservoir

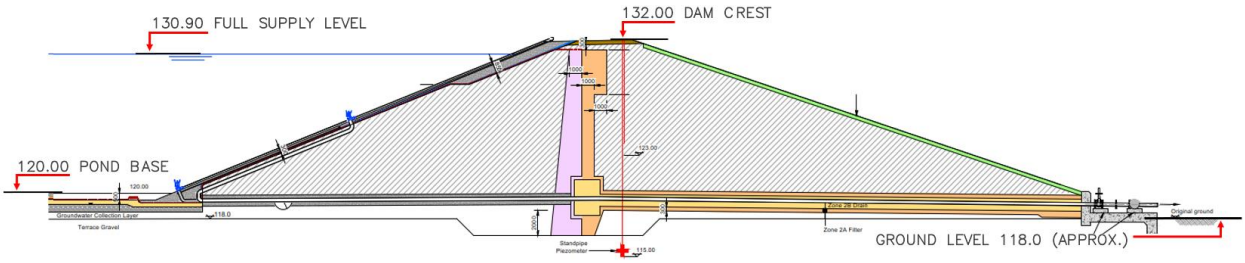


Figure 2 – Typical cross-Section along line Z-Z

5. Dam-Break Flood Hazard

Dam Breach Scenario

The *New Zealand Dam Safety Guidelines* normally require consideration of hypothetical 'sunny day' and 'rainy day' dam failures, the latter occurring in a flood situation. As the proposed Poads Road Water Storage Reservoir is an off-river storage facility, with storm runoff into the reservoir sourced only from its own very small catchment area, it will be unaffected by riverine flooding. Therefore only a sunny day type dam failure has been considered for this "intermediate" level assessment as outlined below[3].

It is assumed that a hypothetical breach in the ring embankment occurs when the dam reservoir is full to the embankment crest level. This assumption has been used as it will provide a

[3] Note that potential failure modes are outlined in Section 7 of the Damwatch (2023) report "Poads Road Water Storage Reservoir – Feasibility Design Report". For this off-river water storage facility, there was no credible potential failure mode identified that relates to failure of the dam in combination with a large flood occurring on the Ohau River. All credible potential failure modes identified related to "sunny day" dam failure scenarios.

conservative indication of the impact of a hypothetical dam-break flood downstream. Only the water stored above natural ground level has the potential to be released in a dam-break flood event. As indicated in Table 1, there is approximately 855,000 m^3 of stored water that could be released downstream if the pond embankment were to breach at the highest embankment on the northern side of the reservoir.

These assumed conditions reflect a potential failure mode where the reservoir is overfilled by pumping (to the embankment crest level) with blockage of the emergency spillway/overflow system and failure of the control system to switch off the pumped inflows. The embankment crest then overtops, resulting in erosion of a breach in the embankment and release of the stored contents of the reservoir downstream.

The breach could occur at any point on the embankment perimeter where it is raised above natural ground level. It has been assumed that breach occurs at the highest embankment on the northern side of the reservoir. This will provide a "worst case" scenario on which to base the PIC for the reservoir embankment.

An alternative breach scenario could be damage to the liner leading to internal erosion either through the embankment or along a conduit penetrating through the embankment, ultimately leading to a breach of the embankment and an uncontrolled release of the reservoir water. However, this breach would occur during normal operating conditions with a lower reservoir level than the assumed breach scenario mentioned above, and result is a less conservative peak breach outflow and volume.

Estimation of Breach Outflow

The peak breach outflow and breach development time[4] for failure at the maximum embankment height have been estimated with the Froehlich (2016)[5] equations. The results are summarised below.

- Reservoir depth at time of failure = 12.0 m (measured from reservoir level at embankment crest to breach invert at pond base 120 m RL)
- Reservoir volume at time of failure (volume between reservoir level at embankment crest to breach invert at pond base at 120 m RL) = approximately 855,000 m^3
- Peak breach outflow: = approximately 660 m^3/s
- Breach development time = approximately 20 to 30 minutes
- Time to empty reservoir = approximately 40 to 50 minutes

Note that, if the breach were to occur at a location where the embankment had a lower height, the peak dam breach outflow and volume released would be less than the values listed above.

A simple, triangular shaped breach outflow hydrograph (Figure 3) was developed based on the parameters listed above and using the methodology outlined in Bowles, et al (2000)[6].

[4] Breach development time is defined in Froehlich (1995) as the time needed for complete development of the final breach.
[5] Froehlich, D. C. (2016). *Predicting Peak Discharge from Gradually Breached Embankment Dam*. Journal of Hydrologic Engineering. Vol. 21, Issue 11.
[6] Bowles, D., Brown, A., Hughes, A., Mark, M., Sayers, P., Topple, A., . . . Gardiner, K. (2013). *Guide to risk assessment for reservoir safety management: Volumes 1 and 2*. Environment Agency, United Kingdom.

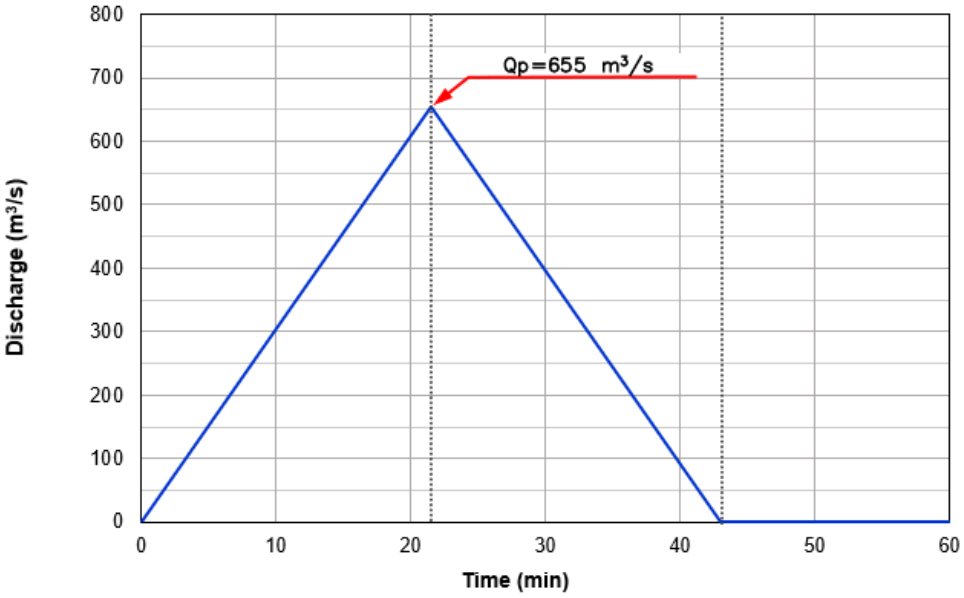


Figure 3 – Poads Road Water Storage Reservoir simplified, triangular breach outflow hydrograph

Dam-Break Flood Inundation Areas

A MIKE21[7] two-dimensional computational hydraulic model of the area downstream of the Poads Road Water Storage Reservoir, following the Ohau River to the coast, was developed for routing of the dam breach outflow hydrograph (Figure 3). The model was used to estimate maximum dam-break flood inundation extents and depths. Ground elevations used in the model were derived from LiDAR aerial survey data supplied by Horizons Regional Council for areas downstream of the Levin Water Treatment Plant (WTP). Table B1 (**Annex B**) provides a summary of the key parameters used to develop the model.

The MIKE21 model was used to simulate the hypothetical dam-break flood scenario described above, based on the breach outflow hydrograph given in Figure 3. A flood map showing the maximum flood inundation area for the hypothetical dam-break flood scenario is provided in **Annex C**. This map indicates areas where flood depths are less than 0.5 m in light blue shading and greater than 0.5 m in dark blue shading.

The dam-break flood inundation map in Annex C indicates that the dam-break flood extent is confined by the river terraces which bound the Ohau River between the reservoir site and the Levin Water Treatment Plant (WTP). Downstream of the Levin WTP the flow breaks out on Ohau River floodplain areas, including locations around Florida Road, just south of the Levin WTP, the Kimberley Reserve and low-lying farmland areas to the west of the SH1 road bridge. It is understood that there are stopbanks along parts of the Ohau River downstream of the SH1 bridge. The crest level of these stopbanks have not been specifically included in the MIKE21 model. Predicted flood depths and extents may differ from those shown on the map in Annex C if the stopbanks are included in future refinements of the MIKE21 model and if a more “comprehensive” level of dam-break flood hazard assessment is required.

[7] MIKE21 is a two-dimensional computational hydraulic modelling package developed by the Danish Hydraulics Institute. This model is widely used internationally and is well suited for simulating complex hydrodynamics associated with dam-break and river flooding.

Figure 3 shows the dam-break discharge hydrographs at locations along the Ohau River to the coast. As can be seen, the peak breach discharge of about 655 m^3/s at the dam breach location attenuates with distance as it is conveyed by the Ohau River and floodplains. At the State Highway (SH) 1 bridge the peak discharge has reduced to about 212 m^3/s and to about 97 m^3/s at the river mouth. T

For comparison, estimated peak flood discharges at the Rongomatane gauging station on the Ohau River are listed in Table 2. The location of this gauging station is indicated on the Figure B1 in Annex B, and is about 500 m downstream of the Poads Road Water Storage Reserve. The peak breach outflow from the dam is roughly equivalent to a 1 in 100 AEP flood on the Ohau River. By the time the dam-break flood reaches the SH1 bridge, the peak flood discharge is estimated to be less than the mean annual flood discharge for the Ohau River of about 234 m^3/s (1 in 2.33 AEP in Table 2).

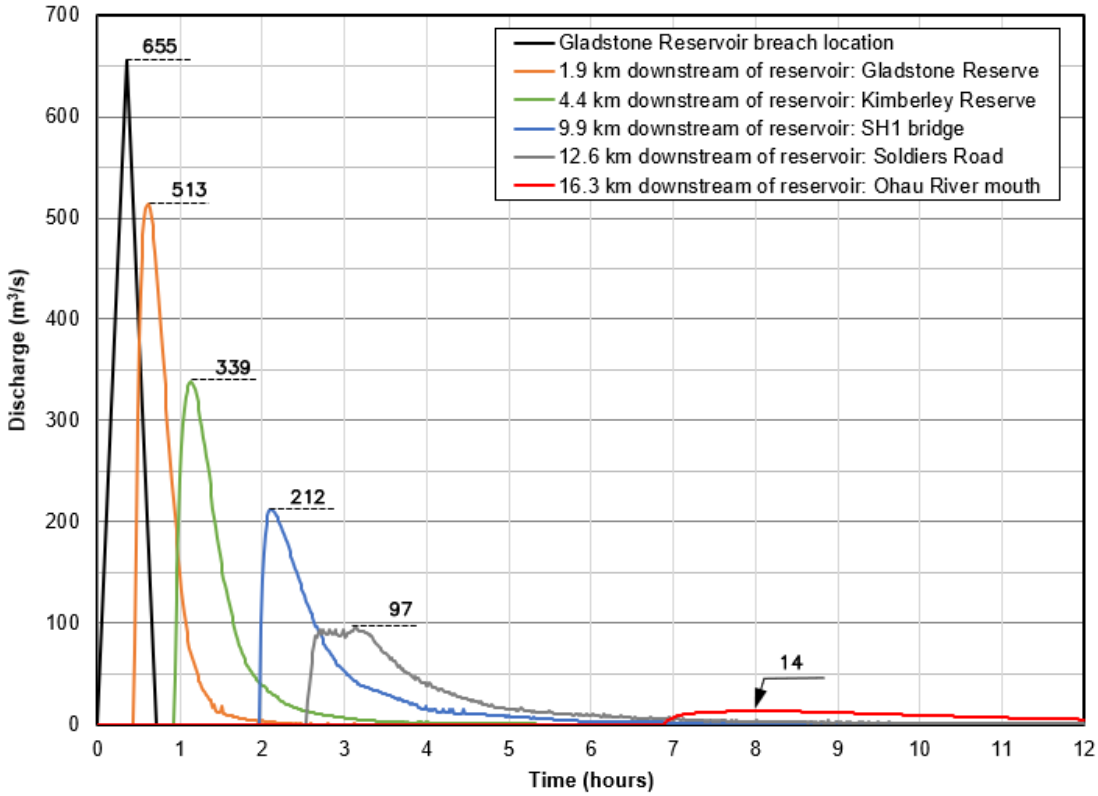


Figure 3 – Dam-break flood discharge hydrographs at locations downstream of the proposed Poads Road Water Storage Reservoir

Table 2 – Flood peak discharge (m^3/s) for the Ohau River at Rongomatane flow gauging site

Source	Annual Exceedance Probability (1 in Years)					
	1 in 2.33	1 in 5	1 in 10	1 in 50	1 in 100	1 in 1000
NIWA (2020)	234	308	367	499	554	738
Philpott (2020)	NA	NA	NA	507	584	NA

References:

NIWA. (2020). *NIWA Flood Frequency Tool [Online]*. National Institute of Water and Atmospheric Research. Available: https://niwa.maps.arcgis.com/apps/webappviewer

Philpott. (2020). *Hydrological and Hydraulic Analysis - Poads Road Bridge*. John Philpott & Associates Ltd.

6. Consequence Assessment & PIC

Introduction

The dam-break flood inundation areas shown in Annex C were overlaid over topographic maps and aerial photographs to determine populated locations potentially impacted by a hypothetical dam failure of the Poads Road Water Storage Reservoir. The Population at Risk was quantified using an approach developed specifically for New Zealand conditions (Veale, *et. al*, 2019)[8]. **Annex D** provides a list of the potentially affected locations of interest in the dam-break flood inundation area. The locations referred to by an "ID Number" in this list are also shown on the flood map in Annex C.

No site inspection was carried out to verify the usage type of potentially affected buildings, listed in Annex D. As such, there is some uncertainty on the usage type (e.g. residential dwelling, commercial building, farm building) of buildings identified from aerial photographs. Buildings were conservatively assumed to be residential dwellings in the case of any such uncertainty.

Assessment of Damage Levels

The following summary describes the potential consequences in terms of the damage level categories listed in the *New Zealand Dam Safety Guidelines* (refer Table A1 in Annex A).

- Community: There are four residential dwellings (shown with ID Numbers 8, 9, 11 and 20 on the flood map in Annex C) in the potential dam-break flood inundation area. Three of these dwellings are inundated to a maximum depth in the range of 0.1 to 0.2 m, and one inundated to a maximum depth of 0.5 m (ID Number 11). These building would be unlikely to receive structural damage but, if the building floor level was close to the ground, dam-break floodwaters could enter those buildings and affect building interiors or contents.

  No community facilities, commercial or industrial facilities were identified in the dam-break flood inundation zone. The Levin Water Treatment Plant intake is described under the "critical or major infrastructure" section below.

  The damage level to the community is assessed to be minor based on Table A1 (Annex A) and a "minimal" damage level is selected for the community category.

- Cultural: A search of the New Zealand Heritage List/Rārangi Kōrero[9] the Department of Conservation national register of heritage sites which they manage[10] and the Horowhenua District Council webmaps[11] indicates there are no historical or cultural sites forming "*part of the historical and cultural heritage of New Zealand*" within the potential dam-break flood inundation area[12].

[8] Veale, B., Webby, G., & Henden, M. (2019). Dam-Break Consequence Assessments: Framework for estimation of population at risk. NZSOLD ANCOLD Combined Conference, 9-12 October 2019, Auckland, New Zealand.
[9] https://www.heritage.org.nz/the-list
[10] https://www.doc.govt.nz/our-work/heritage/heritage-publications/national-register-of-heritage-sites-managed-by-doc/
[11] https://mapit.horowhenua.govt.nz/
[12] Note that only existing, known heritage sites have been considered. This is in accordance with the MBIE (2022) guidance document "*Dam Safety Guidance*" which states that *"the intent is that only historical or cultural sites that have already been identified or designated as heritage sites are considered, rather than seeking out or introducing* ones".

There is no expected loss to any historical or cultural sites and, based on Table A1 (Annex A), "minimal" damage level is selected for the cultural category.

- Critical or Major Infrastructure: Critical or major infrastructure is defined in Table A1 and includes buildings or infrastructure operated by lifeline utilities (e.g. electricity, waters, sewage, gas, telecommunications and transportation systems, etc.) and emergency facilities (e.g. medical, policing, fire services etc.).

  The critical or major infrastructure identified in the dam-break flood inundation area include those listed below.

  - Levin Water Treatment Plant intake (ID Number 8)
  - SH2 road bridge (ID Number 18)
  - North Island Main Trunk railway bridge (ID Number 16)
  - Transpower 220KV overhead powerline and pylons (just upstream of ID Number 22)

  However, the peak dam-break discharges at these structures are all less than a moderate flood on the Ohau River for which these structures are expected to have been designed to withstand. As such, they are not expected to sustain any significant or lasting damage.

  A damage level of "minimal" is selected for "critical and major infrastructure" from Table A1 with a "time to restore operation" of less than one week.

- Natural Environment: The dam breach outflow is expected to largely be confined to the extent shown on the dam-break flood inundation map in Annex C. The land within this inundation zone largely consists of open, floodplain areas near the Ohau River used for agricultural purposes. Local erosion and deposition of silt on the floodplain areas and Ohau River is expected.

  Fish and invertebrate species in the river would be threatened by the sudden increase in river flow due to the dam-break flood and by deposition of eroded embankment material on the riverbed.

  Based on Table 1, the damage level to the natural environment is assessed to be "moderate" representing "significant damage that is practicable to restore or repair" (i.e. naturally heal over time).

The highest damage level from the above categories is "moderate" and this has been selected to assess the PIC.

Assessment of PAR

The population exposed to a potential dam-break flood inundation area is termed the "Population at Risk" (PAR) in the Building (Dam Safety) Regulations. The PAR is defined as "*the number of people likely to be affected by an uncontrolled release of all or part of the stored water or other fluid due to a failure of the dam (assuming that no person takes any action to evacuate)*". The PAR includes both permanent populations (e.g. people in houses or workplaces) and temporary populations (e.g. road users, anglers, farm workers, etc.). Note that estimates of the PAR do not equate to potential loss-of-life estimates.

For the purposes of this assessment, people are considered "likely to be affected" and included in the PAR count where the maximum depth of flooding is greater than 0.5 m deep. This threshold is based on guidance from the *New Zealand Dam Safety Guidelines*.

It is important to emphasise that the assumed hypothetical dam failure of the Poads Road Water Storage Reservoir occurs under sunny day (dry weather) conditions when the downstream PAR would be unsuspecting of any imminent dam-break flood hazard and not expecting to encounter rapidly advancing and rising floodwaters. Anyone within the PAR would have limited warning of the impending flood arrival unless they were alerted by other means.

Locations where PAR could be located are identified with an ID number on the dam-break flood inundation maps in Annex D. The key locations where people could be present and affected by dam-break flood waters greater than 0.5 m in depth, are the residential dwelling near Riveredge Terrace (refer ID Number 3), the Ohau River gravel extraction site near Poads Road (refer ID Number 3), and the Gladstone and Kimberley Reserves (refer ID Numbers 5 and 10). Note that the estimated maximum flood depths around the four impacted residential dwellings (refer to the 'Community" damage category described above) are all less than 0.5 m so that these residential dwellings do not contribute to the PAR.

One person operating machinery at the Ohau River gravel extraction site has been conservatively assumed for PAR assessment purposes. Inspection of aerial photographs also indicates there is a gravel extraction area in the lower portion of the Ohau River (refer ID number 19). However, this area appears to be less frequently used and no population has been assigned for PAR assessment purposes.

There are five reserves managed by Horowhenua District Council (HDC) near the Ohau River. These are the Gladstone Reserve, Kimberley Reserve, Kirkcalides Reserve, a river access way off Muhunoa East Road and Parikawau Reserve and referred to as the "Ohau River Reserves". Of these five reserves, the Gladstone Road, Kimberley and Parikawau Reserves are the most popular (HDC, 2017)[13]. The following lists the occupancy assumptions for these reserves adopted for PAR assessment:

- The Gladstone Reserve (refer ID Number 5) is used as a picnic and swimming access area in the summer and has toilet facilities (HDC, 2017). A PAR estimate of two people during the summer months has been conservatively assumed.
- The Kimberley Reserve (refer ID Number 10) is the largest of the reserves and is a popular spot for camping (by permit from HDC during the summer months) and is also used as a picnic, dog-walking and swimming area (HDC, 2017). Toilet facilities are available. Inspection of satellite photos indicates between two to 20 vehicles are parked in the reserve area during daylight hours in the summer months. Assuming two people per vehicle, an estimate of between four to forty people could be present in the reserve area during the peak of the summer. For PAR assessment purposes, a representative population of 10 people has been adopted for this reserve.
- The other reserves are relatively small and are understood to not be frequently visited. However, the Parikawau Reserve (refer ID Number 17) is known to be used as a layover area for people travelling on SH1 (HDC, 2017). For PAR assessment, no people have been included in these reserves.

[13] HDC (2017). Ohau River Reserves Management Plan. Horowhenua District Council.

The temporary populations at the locations described above will depend on the time of day (i.e. day-time or night-time) and season (e.g. summer or winter) when a potential dam failure event occurs. The assumed population numbers described above represent a situation where a potential dam failure event occurs during the daytime over the summer period.

Table D1 in Annex D also lists the estimated PAR for people in vehicles and on roads affected by the potential dam-break flooding. This indicates that one person in a vehicle on Gladstone Road may be impacted and this person has been included in the total PAR estimate. The calculations listed in Table D2 in Annex D include an assessment of the exposure time to people in vehicles on the roads into account using the methodology outlined in EA (2013)[14].

Finally, people may also be present on agricultural land affected by the dam-break induced flooding. This would occur particularly around the Florida Road area, to the south of the Levin WTP. One person has conservatively been assumed in the total PAR to account for this potential population.

Based on the descriptions above, total PAR estimated in a hypothetical breach of the Poads Road Water Storage Reservoir is in the order of 18 people as listed in Table D1 (Annex D).

Other time periods could be considered for this PAR assessment (e.g. summer night-time, winter daytime and winter night-time) in accordance with the recommendations of Veale *et al* (2019) but the summer daytime period discussed above provides the most conservative estimate of the PAR.

Assessment of Potential Loss of Life

No formal estimates of potential loss of life have been carried out as part of this “intermediate: level assessment. However, the PAR consists of temporary populations either in or near the Ohau River or the Gladstone or Kimberley Reserves at the time of hypothetical dam failure event. In general, the areas downstream of the dam are sparsely populated with no permanent, residential dwellings flooded to a depth greater than 0.5 m. The rapidly rising river and floodplain levels in a hypothetical dam break flood in the Ohau River Reserve areas and in other inundated areas, coupled with some possibility of a notice to evacuate provided by the dam owner, should provide some warning of a potential flood hazard to users of the reserves, roads or river areas. Although there is potential for loss of life, particularly if there are large number of people camping at the Kimberly Reserve area near the water’s edge, it is not expected that a life would be lost.

It should be understood that, the above assessment of Potential Loss of Life has been considered for PIC assessment purposes by consideration of hypothetical event where the dam failed. A PIC assessment only considers the consequences of a hypothetical dam failure with no account taken for the likelihood of that failure.

However, modern water retaining structures, such as the Poads Road Water Storage Reservoir, have an extremely low likelihood of failure. As such, the likelihood of Potential Loss of Life from dam failure is also considered extremely low. This high level of dam safety is achieved by specification of appropriate performance criteria used in the design and construction of a dam (regulated by the Building Code 2004) and by close monitoring and management throughout the

[14] EA. (2013). *Guide to risk assessment for reservoir safety management*. United Kingdom Environment Agency.

operational life of a dam by means of a comprehensive Dam Safety Management System (regulated by the forthcoming Building (Dam Safety) Regulations 2022 for Medium and High PIC structures).

Potential Impact Classification

Using a damage level of “moderate” and a PAR of 1 and no expected Potential Loss of Life, Table A2 (Annex A) indicates that the proposed Poads Road Water Storage Reservoir is Medium.

Note that even if the assessed PAR weas significantly higher than 15 but less than 100, or if the potential loss of life was assessed to be one person, Table A2 (Annex A) indicates that the PIC classification for the reservoir would still be Medium.

7. Conclusions

The PIC of the Poads Road Water Storage Reservoir is assessed to be **Medium**.

8. Limitations & Disclaimer

This assessment was carried out using the Potential Impact Classification assessment methodology set out in the *New Zealand Dam Safety Guidelines*, published by the New Zealand Society on Large Dams in May 2015 and the PIC determination tables published in the Building (Dam Safety) Regulations 2022. Any future changes to the PIC assessment methodology may change the findings of this assessment.

If any future development (particularly residential dwellings) occurred in the dam-break flood inundation area shown on the map in Annex C, this could also affect the assessed PIC of the proposed Poads Road Water Storage Reservoir.

No site inspection was carried out to verify the populated locations identified in Annex D of this memo.

This assessment was carried out using the feasibility design for the proposed Poads Road Water Storage Reservoir described in Section 4. Any changes to Poads Road Water Storage Reservoir design and the parameters listed in Section 4 may change the findings of this assessment.

This letter report has been prepared by Damwatch Engineering Limited solely for the benefit of Horowhenua District Council. No Liability is accepted by Damwatch or any director, employee, contractor or sub-consultant of Damwatch with respect to its use by any other person. This disclaimer shall apply notwithstanding that the letter report may be available for other persons for an application for permission or approval or to fulfil a legal requirement.

9. Attachments

Annex A – PIC Assessment Tables
Annex B – Hydraulic Model Parameters
Annex C – Dam-Break Flood Inundation Map
Annex D – PAR Assessment Tables

ANNEX A – PIC ASSESSMENT TABLES

Table A1 – Determination of Assessed Damage Level (reproduced from the Building (Dam Safety) Regulations 2022)

Damage Level	Specified categories				
	Community	Cultural	Critical or major infrastructure		Natural environment
			Damage	Time to restore to operation [1]	
Catastrophic	One or more of the following apply: • 50 or more household units rendered uninhabitable. • 20 or more commercial or industrial facilities rendered inoperable. • 2 or more community facilities rendered inoperable or uninhabitable.	Irreparable loss to 2 or more historical or cultural sites.	Two or more critical or major infrastructure facilities rendered inoperable.	One year or more.	Extensive and widespread damage, with permanent, irreparable effects on the natural environment.
Major	One or more of the following apply: • 4 or more but less than 50 household units rendered uninhabitable. • 5 or more but less than 20 commercial or industrial facilities rendered inoperable. • 1 community facility rendered inoperable or uninhabitable.	One or both of the following apply: • irreparable loss to 1 historical or cultural site. • loss to 1 or more historical or cultural sites where it is possible, but impracticable, to fully restore the site.	One critical or major infrastructure facility is rendered inoperable.	Three months or more but less than 1 year.	Extensive and widespread damage where it is possible, but impracticable, to fully restore or repair the damage.
Moderate	One or more of the following apply: • 1 or more but less than 4 household units rendered uninhabitable. • 1 or more but less than 5 commercial or industrial facilities rendered inoperable. • loss of some functionality of one or more community facilities.	Significant loss to 1 or more historical or cultural sites where it is practicable to restore the site.	One or more critical or major infrastructure facilities are affected by the loss of some functionality.	Less than 3 months.	Significant damage that is practicable to restore or repair.
Minimal	Minor damage that does not materially affect the functionality of any household unit, commercial or industrial facility, or community facility (or no damage).	Loss to 1 or more historical or cultural sites that will require minor restoration only (or no loss to any historical or cultural site).	Minor damage to 1 or more critical or major infrastructure facilities (or no damage).	One week or less.	Only minor rehabilitation or restoration may be required or recovery is possible without intervention (or no damage).

Table A1 (continued)

Notes associated to Table A1

1. The estimated time required to repair the damage sufficiently to return the critical or major infrastructure to the normal operation that the infrastructure had immediately before the failure of the dam

Supporting Information to Table A1(from Section 3 of the Building (Dam Safety) Regulations 2022)

For the "Community" specified category:

- A commercial or industrial facility:

  (a) means a building, other than a farm building, that is used for commercial, business, industrial, or professional purposes, but;

  (b) does not include any critical or major infrastructure.

- A community facility means any of the following:

  (a) an early childhood education and care centre or registered school within the meaning of section 10 of the Education and Training Act 2020.

  (b) the premises of an institution within the meaning of section 10 of the Education and Training Act 2020.

  (c) a rest home or a residential disability care institution (within the meaning of section 58(4) of the Health and Disability Services (Safety) Act 2001).

  (d) a building that is used to provide health or disability services as defined in section 5 of the Health and Disability Services (Safety) Act 2001 (other than a hospital building referred to in paragraph (b) of the definition of critical or major infrastructure).

  (e) a marae, a community hall, or an event centre.

For the "Cultural" specified category:

- Historical or cultural sites:

  (a) means any of the following that forms a part of the historical and cultural heritage of New Zealand:
  (i) land, including an archaeological site, a cemetery, or urupā (or part of an archaeological site, cemetery, or urupā).
  (ii) a building or structure (or part of a building or structure).
  (iii) any combination of land, buildings, structures, or associated buildings or structures (or parts of buildings, structures, or associated buildings or structures), and;

  (b) includes any thing that is in or fixed to land described in paragraph (a)

For the "Critical or major infrastructure" specified category.

- Critical or major infrastructure means any of the following:

  (a) building or other infrastructure operated or used by a lifeline utility within the meaning of section 4 of the Civil Defence Emergency Management Act 2002 (e.g. electricity, water, sewage, gas, telecommunications and rail infrastructure).

  (b) a hospital building that is likely to be needed in an emergency (within the meaning of section 4 of the Civil Defence Emergency Management Act 2002) to provide:
  (i) emergency medical services, or;
  (ii) ancillary services that are essential for the provision of emergency medical services.

  (c) a building that is used to provide emergency response services (for example, policing, fire, ambulance, or rescue services).

  (d) buildings or infrastructure that are essential to the containment of a hazardous substance (as defined by section 2 of the Hazardous Substances and New Organisms Act 1996):

  (d) the dam, another dam, or flood protection works if the service that the dam, other dam, or flood protection works provide is critical to the community and that service cannot be reasonably provided by alternative means

Table A2 - Determination of Dam's Potential Impact Classificaiton (reproduced from Schedule 2 of the Building (Dam Safety) Regulations 2022)

Assessed damage level	Population at Risk (PAR)				Potential Loss of Life
	0	1 to 10	11 to 100	More than 100	
Catastrophic	High	High	High	High	No persons
	N/A (see Note 1)	High	High	High	One person
	N/A (see Note 1)	High	High	High	Two or more persons
Major	Medium	Medium	High	High	No persons
	N/A (see Note 1)	Medium	High	High	One person
	N/A (see Note 1)	High	High	High	Two or more persons
Moderate	Low	Low	Medium	Medium	No persons
	N/A (see Note 1)	Medium	Medium	Medium	One person
	N/A (see Note 1)	High	High	High	Two or more persons
Minimal	Low	Low	Low	Low	No persons
	N/A (see Note 1)	Medium	Medium	Medium	One person
	N/A (see Note 1)	High	High	High	Two or more persons

Notes associated to Table A2

1. Not applicable. Population at risk is zero therefore no potential loss of life.

Supporting Information to Table A2 (from Section 3 of the Building (Dam Safety) Regulations 2022)

- *Population at Risk (PAR) means:* the number of people likely to be affected by an uncontrolled release of all or part of the stored water or other fluid due to a failure of the dam (assuming that no person takes any action to evacuate)
- *Potential Loss of Life means:* the number of people expected to lose their life as a result of an uncontrolled release of all or part of the stored water or other fluid due to a failure of the dam.

ANNEX B – HYDRAULIC MODEL PARAMETERS

Parameters	Description
Model type	MIKE21-FM
Model extent	Ohau River and floodplains from proposed Poads Road Water Storage Reservoir at end of Roads Road to coast.
Topographic data	Digital Elevation Model derived from: ● Horowhenua District Council c.2010 LiDAR aerial survey for areas downstream of Levin Water Treatment Plant (refer Figure B1). ● Horowhenua District Council 2016 photogrammetry survey for areas upstream of Levin Water Treatment Plant (refer Figure B1).
Model mesh	An orthogonal (square) mesh with 10 m x 10 m grid resolution was used.
Model scenarios	Hypothetical 'sunny day' breach of proposed Poads Road Water Storage Reservoir ring embankment (refer Section 5 of this memorandum).
Model calibration	There are no known historical flood data (i.e. flood extents or flood debris marks) within the model extent to calibrate the model. However, future updates to the model could use recorded flood discharge and water level data from the Ohau River @ Rongomatane gauging station to validate the model predicted water levels at that location.
Boundary conditions	● Upstream: Dam-break outflow hydrograph (refer Figure 3) ● Downstream: Constant tidal boundary level set to 0 m RL, approximating mean sea level.
Roughness coefficients	● Global Manning's "n" roughness coefficient equal to 0.05
Hydraulic structures	● No special treatment of bridges, dikes, etc in the river floodplain areas.
Model Outputs	● 2D grids (10 m x 10 m) of flood extent, depth and velocity

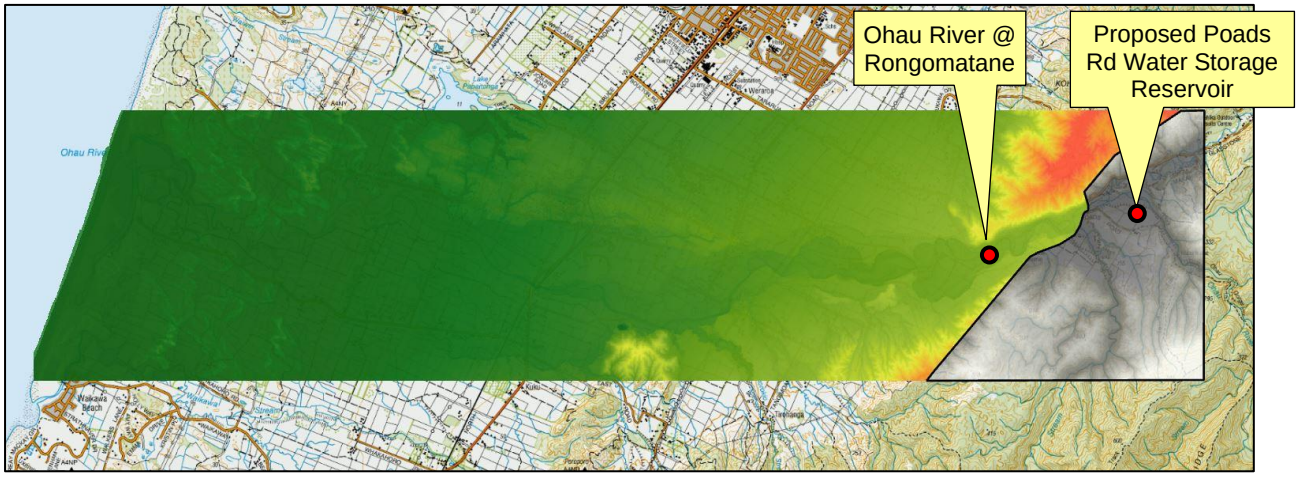


Figure B1 – Extent of MIKE21-FM model domain, showing coverage of LiDAR aerial survey (red to green shaded area) and 2016 photogrammetry survey (grey shaded area)

ANNEX C – DAM-BREAK FLOOD INUNDATION MAP

Legend

- Location of Interest "ID Number"
- Poads Road Water Storage Reservoir

Indicative maximum dam-break flood depth

- < 0.5 m
- > 0.5 m

LEVIN WATER TREAMENT PLANT (WTP) INTAKE

PROPOSED POADS ROAD WATER STORAGE RESERVOIR

ID Number*	Description
1	Upper Ohau River gravel extraction area 1
2	Poads Road bridge
3	Upper Ohau River gravel extraction area 2
4	Private Road bridge
5	Gladstone Reserve
6	Farm Buildings
7	Levin WTP Intake
8	Residential Dwelling
9	Residential Dwelling
10	Kimberley Reserve
11	Residential Dwelling
12	Pipe Bridge
13	Muhunoa East Road bridge
14	Kirkcaldies Reserve
15	Muhunoa East Road river access area
16	Railway bridge
17	Parikawau Reserve
18	Stage Highway 2 bridge
19	Lower Ohau River gravel extraction area
20	Residential Dwelling
21	Private Road bridge
22	Private Road bridge

* Refer to memorandum "Potential Impact Classification for proposed Gladstone Reservoir" dated 20/01/2022, for further desecption of "ID Numbers" referred to on this map.

ANNEX C

Poads Road Water Storage Reservoir
Potential Dam-Break Flood Inundation

DAMWATCH ENGINEERING BEYOND THE SURFACE

1. The information contained in this map DOES NOT in any way reflect the structural integrity or likelihood of failure of the Poads Road Water Storage Reservoir.
2. The map should not be used without prior reference to the accompanying memorandum "Potential Impact Classification for proposed Gladstone Reservoir" dated 13/02/2023 which describes the methodology to produce the map and its limitations.
3. Background mapping (Land parcel boundaries and Topo50 map) sourced from Land Information New Zealand (LINZ) and licensed by LINZ for re-use under the Creative Commons Attribution 4.0 New Zealand licence: *https://creativecommons.org/licenses/by/4.0/*

DATE:	14/02/2023
PREPARED BY:	BV
CHECKED BY:	GW
APPROVED BY:	SM
REVISION NUMBER:	01
REFERENCE:	E2142A

SCALE:

1:50,000

0 750 1,500 2,250 3,000 m

Eagle Technology, Land Information New Zealand

ANNEX D – PAR ASSESSMENT TABLES

Table D1 – PAR estimation summary

ID Number[a]	Populated Location	Unit	Number	Occupancy Rate	Maximum Flood Depth (m)	Population at Risk [d]
Fixed Locations						
1	Upper Ohau River gravel extraction area 1	No.	1		0.2	
2	Poads Road bridge	No.	1		3.4	
3	Upper Ohau River gravel extraction area 2	No.	1	1	0.8	1
4	Private Road bridge	No.	1		3.4	
5	Gladstone Reserve	No.	1	2	1.0	2
6	Farm Buildings[b]	No.	1		0.3	
7	Levin WTP Intake	No.	1		0.1	
8	Residential Dwelling	No.	1		0.1	
9	Residential Dwelling	No.	1		0.2	
10	Kimberley Reserve	No.	1	10	0.6	10
11	Residential Dwelling	No.	1		0.5	3
12	Pipe Bridge	No.	1		2.8	
13	Muhunoa East Road bridge	No.	1		3.4	
14	Kirkcaldies Reserve	No.	1		0.5	
15	Muhunoa East Road river access area	No.	1		0.1	
16	Railway bridge	No.	1		2.7	
17	Parikawau Reserve	No.	1		0.3	
18	Stage Highway 2 bridge	No.	1		2.5	
19	Lower Ohau River gravel extraction area	No.	1		0.5	
20	Residential Dwelling	No.	1		0.1	
21	Private Road bridge	No.	1		0.4	
22	Private Road bridge	No.	1		1.7	
Transportation Routes [c]						
-	Gladstone Road (refer Table D2)	-	-	-	-	1
Other Populated Areas						
-	Agricultural land	-	-	-	-	1
					Total Population at Risk (PAR)	**18**

Notes:
[a] Refer to flood map in Annex C for "ID Number" locations
[b] Population in farm sheds, accounted for in estimate of people on surrounding horticultural and farm land.
[c] Refer Table D2 for PAR estimates at transportation routes.
[d] Locations subject to depths < 0.5 m not included in PAR estimates.
[e] Assume 3 people per residential dwelling flooded to depth < 0.5 m.

Table D2 – PAR estimation for transportation routes

Parameter	Symbol	Poads Road	Gladstone Road	Arapaepae Road	Muhunoa East Road	Muhunoa West Road	Soldiers Road	Riveredge Terrace Road	Florida Road
Number of vehicles per day*	AADT	22	325	637	332	297	95	2	20
Number of people per vehicle**	Nv	2	2	2	2	2	2	2	2
Average speed (kph)	V	60	80	80	80	80	80	30	70
Length of road or inundated (km)***	L	0.29	0.39	0.04	0.24	0.30	0.27	0.05	0.81
Hazard exposure time (minutes)	t	0.29	0.29	0.03	0.18	0.22	0.20	0.10	0.69
PAR in inundation zone at time of dam break +	P1	0.0	0.3	0.1	0.2	0.2	0.1	0.0	0.0
PAR driving into inundation zone before road closed ++	P2	0.0	0.5	0.1	0.3	0.4	0.1	0.0	0.1
PAR +++	PAR	0	1	0	0	0	0	0	0

Notes:

* Annual Average Daily Traffic (AADT) taken from https://mobileroad.org for Horowhenua District Council

** Two people per vehicle conservatively assumed

*** Length of road inundated derived from Geographic Information System (GIS) measurement

+ Population on route and in inudation zone when dam-break flood occurs

++ EA (2013) suggests doubling the intial PAR estimate to account for vehicles driving into a length of inundated road before it is closed

+++ Equal to P2, rounded to nearest whole number

Appendix C

REASONABLE USE ASSESSMENT

MEMORANDUM

ASSESSMENT OF REASONABLE USE ESTIMATE FOR LEVIN WATER SUPPLY

Date: July 2024

This memo has been prepared to provide an assessment of the volume of water take considered as 'reasonable and justifiable use' for the Levin Water Supply network, servicing the water needs of the town of Levin, Horowhenua, including some properties in Ohau.

An assessment of the volume of water take considered as a 'reasonable and justifiable use' for the Levin Water Supply network had last been determined by Good Earth Matters Consulting Limited (Good Earth Matters) in March 2023, as was determined by application of the Horizons Regional Council (Horizons) "One Plan", Part I - Regional Policy Statement, Policy 5-12, which was the governing policy at that time.

One Plan Amendment 3 (2024)

The Horizons One Plan was amended on 27 February 2024 to give effect to the National Planning Standards (NPS). Consequently, the provisions of the One Plan have been restructured and renumbered, with clauses and definitions being added or changed. The wording of the policy provisions for 'reasonable and justifiable need were not amended.

However, noting the time that has passed since the previous assessment and that a further year of water use data is now available, the previous reasonable use assessment has been updated, as per this memo.

Regional Policy Statement - LF - Land and Freshwater

The Regional Policy Statement (RPS, now Part II of the Horizons One Plan as Amended by Plan Amendment 3 (2024)) addresses the management of fresh water in the Region. Among other objectives relating to water management, the RPS addresses Water Quantity, stating that:

> *"The demand of surface water* and groundwater resources is one of the most critical issues addressed in the Plan."*

Policy LF-FW-P15: Reasonable and justifiable need for water (previously Policy 5-12), requires the amount of water to be taken by resource users to be reasonable and justifiable for the intended use. It defines what, for the purposes of allocation under the RMA, is to be considered as "reasonable and justifiable" use of water. For public water supplies such as the Levin water supply, this is defined in part (4) of One Plan Policy LF-FW-P15.

In undertaking this assessment, it is important to note that the community has not been subject to individual metering of properties and connections and therefore there is no accurate metered data to characterise each of the separate elements of the LF-FW-P15 part (4) assessment. Council has recently adopted universal metering and is in the process of rolling out (installing) meters on all connections. The roll out began in March 2024 and is expected to be completed in 2025.

The approach taken for this application has therefore been to use the most accurate and representative data available to estimate the likely range of each of the elements, supplemented by industry standard measures where necessary, and to err on the side of under-estimation (ie provide a conservatively low estimate of reasonable and justifiable need in order to avoid overstating the need for water to be allocated).

Basis for Calculating "Reasonable and Justifiable" Water Use

Within the context of the Resource Management Act decision making process, the Regional Policy Statement (One Plan, Part II) provides the policy framework for assessing the quantity of water which must generally be considered to be reasonable use of water for public water supply purposes. In particular, One Plan Policy LF-FW-

P15(4) defines what is considered "reasonable and justifiable use" for water allocation for public water supplies within the Region. This policy states:

> *"4. For public water supplies*, the following must generally be considered to be reasonable:*
>
> *(a) an allocation of 300 litres per person per day for domestic needs, plus*
>
> *(b) an allocation for commercial use equal to 20% of the total allocation for domestic needs, plus*
>
> *(c) an allocation for industrial activity* calculated, where possible, in accordance with best management practices for water* efficiency for that particular industry, plus*
>
> *(d) an allocation necessary for hospitals, other facilities providing medical treatment, marae, schools or other education facilities*, New Zealand Defence Force facilities or correction facilities, plus*
>
> *(e) an allocation necessary for public amenity and recreational facilities such as gardens, parks, sports fields and swimming pools, plus*
>
> *(f) an allocation necessary to cater for the reasonable needs of animals or agricultural uses that are supplied by the public water supply* system, plus*
>
> *(g) an allocation necessary to cater for growth, where urban growth of the municipality is provided for in an operative district plan for the area and is reasonably forecast, plus*
>
> *(h) an allocation for leakage equal to 15% of the total of (a) to (g) above."*

The following sections detail the determination of an allocation for each section of LF-FW-P15(4). A summation of these provides an estimated volume of water usage for the community serviced by the Levin water supply which may be considered "reasonable and justifiable use" under the provisions of the Regional Policy Statement.

Horowhenua District Council Non-Residential Water Meter Data

Horowhenua District Council (HDC) officers have supplied Good Earth Matters with data relating to non-residential, metered water connections. HDC Non-Residential Water Billing (WB) metered data has been classified by Council into the following categories:

- Commercial
- Community Services
- Industrial
- Lifestyle
- Multi-Use
- Recreational
- Rural Industry
- Transport
- Utility Services

These categories do not fully align with the categorisation in LF-FW-P15 (4) (a - f) The below analysis details which categories have been applied to each of the sections of LF-FW-P15 (4) for the purposes of this assessment.

Analysis of this data indicates outlier and/ or erroneous data points. Upon visual inspection, the Total Water Consumption (m^3/ year) data from 2016 and 2017 water years, from 1 July 2015 - 30 June 2016 and 1 July 2016 - 30 June 2017 respectively, being from 1 July 2015 - 30 June 2017 collectively, have generally been disregarded.

Likewise, the more-recent data from the 2023 water year, being 1 July 2022 - 30 June 2023, was also generally disregarded.

The Total Water Consumption (m^3/ year) for the 2016 and 2017 water years were 46% and 17% respectively of the average of other years' Total Water Consumption, indicating that those two years were likely underreported water use and /or part-year data only. Likewise, the Total Water Consumption (m^3/ year) for the 2023 water year was 296% of the average of other years' Total Water Consumption, indicating that this data was likely overreported water use.

It has been considered that some other individual data points which appear to be outliers are also erroneous and have likewise been disregarded from analysis within the discrete category classifications of HDC Non-Residential WB metered data. A couple of examples of such data outliers appear in the "Commercial" data, which in 2016 with 23,588 m^3/ year from 93 connections was approximately half (50%) of the previous six (6) years, from 93 connections (a greater number than the previous 6 years, ranging from 74 - 90 connections). The following year's "Commercial" data for 2017 was only 31 m^3/ year from only 2 connections, which is almost zero consumption for this category.

Likewise, the "Utility Services" data for 2016 was 1,260 m^3/ year from 11 connections, being considerably less than the previous 6 years from the same connections, and in 2017 was only 5 m^3/ year from 2 connections. The following year in 2018 the "Utility Services" category recorded 228,686 m^3/ year from 12 connections.

Where these described data points have been observed and considered to be outliers or erroneous, Good Earth Matters has not sought to investigate and/ or verify the accuracy or validity of those data points with HDC officers, but rather marked those data points to be disregarded from the data set of each category classification, and the remaining data points within each set considered for range and/ or average estimations.

These Council-defined categories have been considered as being reflective of LF-FW-P15 (4) sections (b) to (f), except for a clear definition of "Multi-Use" from Council. For comparison between the LF-FW-P15 (4) sections and Council metered data, the "Multi-Use" category has been grouped with the "Commercial" category.

Policy LF-FW-P15 (4) (a) an allocation of 300 litres per person per day for domestic needs

The public register of Drinking Water Supplies was previously held by the Ministry of Health, prior to November 2021. This public register was transferred from the Ministry of Health to Taumata Arowai when Taumata Arowai became the water services regulator on 15 November 2021.

As official record of the drinking water regulator, the domestic population serviced by drinking water supplies is now held by Taumata Arowai in the "Public Register of Drinking Water Supplies". This register can be accessed at the following link: https://www.taumataarowai.govt.nz/for-communities/public-register/.

Under the Territorial Authority designation of Horowhenua District Council, the Levin supply (Supply ID LEV001) is registered as a 'Networked Supply' serving the community of "Levin, Ohau". This water supply services both Levin, the largest town in the Horowhenua District, as well as parts of Ohau, which is a small semi-rural community located just South of Levin on State Highway 1, and immediately North of the Ohau River (from which the supply abstracts water further upstream). The registered population of this drinking water supply is 22,000 persons.

Applying an allocation of 300 L/ person/ day for domestic needs, the Policy LF-FW-P15 (4) (a) assessment for the Levin supply equates to 6,600,000 L/ day, which may be more usefully expressed as 6,600 m^3/ day.

Policy LF-FW-P15 (4) (b) an allocation for commercial use equal to 20% of the total allocation for domestic needs

The determination of an allocation of water for commercial use by definition of Policy LF-FW-P15 (4) (b) is to be equivalent to 20% of the total allocation for domestic needs, as calculated by Policy LF-FW-P15 (4) (a), which allocates a quantity (volume) of 300 L/ person/ day for the population serviced by the Levin water supply network.

By this RMA Policy definition, the Policy LF-FW-P15 (4) (b) assessment for commercial use on the Levin supply equates to 1,320,000 L/ day, which is more usefully expressed as 1,320 m^3/ day.

As discussed in the previous section of this memorandum, HDC Non-Residential Water Billing (WB) metered data has also been analysed to provide a real-life comparison to the Policy LF-FW-P15 assessment estimate.

HDC non-residential metered data classified as "Commercial" ranges from an average of 119 m^3/ day between 2010 - 2015 to 164 m^3/ day between 2018 - 2024.

HDC metered data classified as "Multi-Use" ranges from an average of 81 m^3/ day between 2010 - 2015, for 5 connections to the Levin water supply network, to reduce to an average of 75 m^3/ day between 2018 - 2024 for 7 connections (disregarding outlier data from 2022 and 2023 for this category).

The combination of this non-residential metered data (i.e., the "commercial" plus "multi-use" categories) ranges from 200 - 239 m^3/ day. With respect to the Total of metered data for the 7-year period of 2018 - 2024 at an average of 1,030 m^3/ day, this represents between 19 - 23% of the Total metered usage.

Of note, the Total Consumption of non-residential metered data for the past 7 years from 2018 - 2024 has averaged 1,030 m^3/ day, which is approximately 80% of the Policy LF-FW-P15 (4) (b) definition for allocation of 1,320 m^3/ day towards commercial use category.

In this regard, the Total Consumption of non-residential metered data for the past 7 years from 2018 - 2024 at an average of 1,030 m^3/ day, which may be considered as being reflective of LF-FW-P15 (4) sections (b) to (f),is less than the definition of 'commercial use' allocation by Policy LF-FW-P15 (4) (b) alone.

Policy LF-FW-P15 (4) (c) an allocation for industrial use calculated, where possible, in accordance with best management practices for water efficiency for that particular industry

As mentioned above, Horowhenua District Council (HDC) officers have supplied data relating to non-residential, metered water connections.

An estimation of allocation for current industrial use may be taken solely from the "Industrial" category data, thereby providing a low range estimate. By averaging the 2018 - 2024 data, an estimate of 422 m^3/ day is obtained (which is 41% of Total metered connections, at 1,030 m^3/ day).

However, this "Industrial" category data appears to have considerably increased in the 2023 and 2024, by as much as 5 to 10 times that of the 2021 and 2022 years, from only 15% greater number of connections. By excluding those 2023 and 2024 data points as being erroneous, to averaging only the 2018 - 2022 data records, an estimate of 195 m^3/ day is obtained (which is 19% of 1,030 m^3/ day for Total metered connections).

Alternatively, a high range estimate of the current industrial use was considered to be represented by the water meter data of the Industrial, Rural Industry, Transport and Utility Services combined. By excluding those data points which appear to be erroneous from the 2018 - 2024 data and summing the average daily usage data from each of these collective 'industrial use' categories, an estimate of 364 m^3/ day was calculated (which is 35% of Total metered connections, at 1,030 m^3/ day).

In this regard, the current 'industrial use' water consumption for Levin from the non-residential metered connection data has been estimated to be within a range of 195 - 364 m^3/ day.

Policy LF-FW-P15 (4) (c) refers to the industrial use component being "…calculated, where possible, in accordance with best management practices for water efficiency for that particular industry". It is not known whether the industry of Levin is operating in accordance with best management practices or not. As such, it has been assumed

that there may be up to 20% savings to be made across the industry sector's water usage if current use did not reflect best management practices for water efficiency and that these practices were then to be adopted.

With an efficiency saving being estimated at a maximum of 20%, the "industrial use" allocation has been estimated at 80% of the Council's non-residential metered water data for Industry.

The Policy LF-FW-P15 (4) (c) assessment has been estimated to be between 156 m^3/ day - 291 m^3/ day.

This is likely an under-estimation given that Alliance Meats has, in the past, used up to 2,200 m^3/day at their site in peak processing conditions (pers comm HDC, Paul Gaydon).

Policy LF-FW-P15 (4) (d) an allocation necessary for hospitals, other facilities providing medical treatment, marae, schools or other education facilities, New Zealand Defence Force facilities or correction facilities

The allocation assessment under Policy LF-FW-P15 (4) (d) is determined by summation of the individual service facilities categories as follows.

Hospitals and Medical Treatment Facilities

Health NZ - MidCentral lists only one (1) facility within Levin, being the Horowhenua Health Centre in Liverpool Street, Levin. This facility has a metered water supply connection, but it is unknown which of the metered data categorisations this is assigned to.

Other private, commercial health service providers within Levin are on metered water supply connections. As above, it is unknown which of the metered data categorisations this is assigned to.

To err on the side of under-estimation, thereby being conservative with the LF-FW-P15 estimate, no allowance for daily water usage has been estimated for Health facilities.

Schools and other Educational Facilities

The register of education facilities can be found at the link https://www.educationcounts.govt.nz/directories/list-of-nz-schools. There are 10 registered schools within the Levin public water supply network area, with a total school role of 3,585 students.

The largest school role is at Horowhenua College on Weraroa Rd, with 879 students, followed by Waiopehu College on Bartholomew Rd with 595 students. The other schools range from 140 - 390 students, averaging 264 students per school.

After reviewing the websites of several of these schools in Levin, an allowance of 120 staff for large schools (2), 40 staff for medium-large schools (3), 30 for medium schools (3), and 25 staff for the small schools (2) has been made, encompassing both teaching and administration/ support staff. This represents a total of approximately 500 staff across the 10 schools, in addition to the 3,585 students. The number of people to be accounted for by schools has been determined to be approximately 4,100 persons.

School water use has been estimated in accordance with allowances detailed in AS/NZS 1547:2012 for On-site Domestic Wastewater Management, based upon the assumption that drinking water demand will be approximately equivalent to wastewater demand. Table H4 on Page 124 of AS/NZS 1547:2012 provides a typical wastewater design flow of 15 -30 Litres/ person/ day.

An allowance for schools in Levin will be within the range of 61,500 - 123,000 Litres/ day (61.5 - 123 m^3/ day).

While there may be some discrepancy/ error in the school staff estimate number, any impact of the staff number will be insignificant, when considering that 61.5 - 123 m^3/ day represents 0.8% - 1.5% of the Total allocation

determined by the Policy LF-FW-P15 (4) assessment total of sections (a) to (g) in the present-day situation, prior to the leakage allocation of section (h). By removing the staff number estimate entirely, and solely using the registered school role numbers of 3,585 students for this allocation, the school allowance estimate is 53,775 - 107,550 Litres/ day. This in turn represents 0.7% - 1.3% of the Policy LF-FW-P15 (4) Total in the present-day.

Therefore, the estimation of school staff numbers which has been made at 500 persons has an impact on the Total allocation of the Policy LF-FW-P15 (4) assessment of not more than 0.2%, and the effect of this assumption on the overall assessment has been taken to be less than minor.

Marae

The Ministry of Māori Development Te Puni Kōkiri website lists Iwi by region (https://tkm.govt.nz/region/te-moana-o-raukawa/), from which the number of Marae connected to the Levin public water supply have been determined. Two Iwi, Muaūpoko and Ngāti Raukawa ki te Tonga, are identified as having Marae in the Levin water supply area.

Muaūpoko Iwi

There are two (2) Marae listed for 7 Hapū, being Kawiu Marae, 294 Kawiu Road, Levin, and Kohuturoa Marae, 306 Hokio Beach Road, Hōkio Beach. Both Marae are serviced by the Levin public water supply according to HDC asset data (online maps).

Ngāti Raukawa ki te Tonga Iwi

A total of 22 Hapū/ Marae are listed. It is apparent that none of these Marae are serviced by the Levin water supply, as they are not located within the Levin public water supply area shown by HDC asset data (online maps).

Therefore, a total of two (2) Marae are serviced by the Levin public water supply. An allocation of 18 m^3/ day has been estimated, at 9 m^3/ day/ Marae. This is representative of the domestic needs allocation of 30 persons/ day (at 300 Litres/ person/ day) for each Marae, noting that actual use is likely to vary considerably depending on hui, tangihanga or other events held at the marae.

New Zealand Defence Force and Corrections Facilities

No NZDF facilities are known of within the Levin water supply area.

The Department of Corrections website (corrections.govt.nz) lists locations throughout the country, which can be searched by region. There are no Prison facilities within Levin.

Within the Levin water supply area, the only listed facility is Levin Community Corrections, at 6 Liverpool Street, Levin. This facility has a metered water supply connection.

Once again, to err on the side of under-estimation for the Policy LF-FW-P15 reasonable use assessment, no allowance has been estimated for either NZ Defence Force or Corrections facilities.

The Policy LF-FW-P15 (4) (d) assessment comprises an allowance of 61.5 - 123 m^3/ day for Schools and Other Educational Facilities, plus 18 m^3/ day for Marae. This provides an assessment estimate of 79.5 - 141 m^3/ day.

With respect to HDC non-residential, metered water connections, the data categorised as "Community Services" would be applicable to Policy LF-FW-P15 (4) (d) allocation estimate. The metered data from 2018 - 2024 yields an average of 61 m^3/ day from an average of 50 connections.

In of itself, the "Community Services" categorised non-residential, metered water connections data represent less than 80% of the lower range estimated allocation of 79.5 m^3/ day for Policy LF-FW-P15 (4) (d).

Policy LF-FW-P15 (4) (e) an allocation necessary for public amenity and recreational facilities such as gardens, parks, sports fields and swimming pools

Policy LF-FW-P15 (4) (e) does not specify a prescribed means of determining this allocation based upon community population or such, as individual communities have considerably different extents of public amenity facilities as needed to service the needs of those individual communities.

For the purposes of this desk-top assessment, Council's non-residential metered water data under the category of "Recreational" has been assessed for this allocation. This data is from water meter connections to the Levin Water Supply for public amenity facilities, of which there were 10 connections for 2018 - 2020, then 11 connections for 2021 - 2022, and 15 connections for 2023 - 2024. The average daily water consumption of these connections for the past 7 years, from 2018 - 2024, has been 6.8 m^3/ day.

The Policy LF-FW-P15 (4) (e) assessment for public amenity and recreational facilities is estimated at 7 m^3/ day.

Policy LF-FW-P15 (4) (f) an allocation necessary to cater for the reasonable needs of animals or agricultural uses that are supplied by the public water supply system

As with Policy section LF-FW-P15 (4) (e) above, Policy LF-FW-P15 (4) (f) does not specify a prescribed means of determining this allocation for the reasonable needs of animals of agricultural uses that are supplied by the public water system. Therefore Council non-residential metered water data for the category of "Lifestyle" network connections has been analysed regarding the assessment of Policy LF-FW-P15 (4) (f) allocation.

From 2018 - 2024 the number of connections in this category has increased from 208 in 2018 to 347 in 2024, increasing between 5% - 18% year upon year.

Water consumption in this category was 53,480 m^3 in 2018 across those 208 connections (Assessments) for an average of 147 m^3/ day or 0.70 m^3/ day/ connection. In 2023, water consumption in this category was 91,998 m^3 across 327 connections for an average of 252 m^3/ day, which equated to 0.77 m^3/ day/ connection. While the daily water usage across the total number of Lifestyle network connections has increased by 72% from 147 m^3/ day to 252 m^3/ day, the water usage per connection has increased by only 10% from 0.70 m^3 to 0.77 m^3/ day/ connection.

The "Lifestyle" metered data for 2024 annual water consumption appears to be erroneous, and was disregarded above.

The annual water consumption data for 2024 was not considered representative of current water demand, recording an annual consumption of 55,431 m^3/ year from 347 connections. This data represents a reduction of over 36,000 m^3 (-40%) from the previous year (2023, 91,998 m^3) while also being from 20 greater number of connections (+6%). This annual volume is more reflective of the 2018 water consumption, albeit from 347 connections in 2024 versus only 208 connections in 2018. The 2024 data equates to an average consumption of 152 m^3/ day for the "Lifestyle" category, however from 347 connections this is only 0.44 m^3/ day/ connection. For this reason the "Lifestyle" category data from 2024 has not been considered.

The average water consumption from 2018-2023 was 76,629 m^3/ year, with the number of connections averaged to 270 per year, for an average of 210 m^3/ day or 0.78 m^3/ day/ connection.

Each "Lifestyle" property (water connection) has been assumed to have a single dwelling on the property. It has also been assumed that occupancy rates of Lifestyle property dwellings are equivalent to the district average, to determine the population living on those Lifestyle properties, and thereby the "domestic needs" allocation of that population, applying the 300 Litres/ person/ day allowance of Policy LF-FW-P15 (4) (a).

The 2018 Census determined a population of 33,261 persons in the Horowhenua District, residing across 13,302 usually occupied dwellings. This yields an average occupancy rate of 2.50 persons/ dwelling in the Horowhenua District.

By calculating the domestic needs allocation of Lifestyle property population estimates in each of (i) the 2018 year, (ii) the 2023 year, and (iii) the average of the 6-year period, and then subtracting that from the Lifestyle metered data, the difference yields the 'other' water consumption on those Lifestyle metered connections, which has been attributed to being used for the needs of animals or other agricultural uses. In 2018, the domestic needs calculation came to 37 m³/ day less than the 147 m³/ day average water consumption of "Lifestyle" network connections. This 37 m³/ day difference has been attributed to the needs of animals or agricultural use. However, in 2023 as well as for the average of 2018 - 2023 years, the domestic needs calculation was greater than the 252 m³/ day and 210 m³/ day average water consumption figures respectively. In these instances the "needs of animals or agricultural use" has been estimated at 0 m³/ day.

The Policy LF-FW-P15 (4) (f) assessment for the reasonable needs of animals or agricultural use that are supplied by the public water supply has been estimated at up to 37 m³/ day.

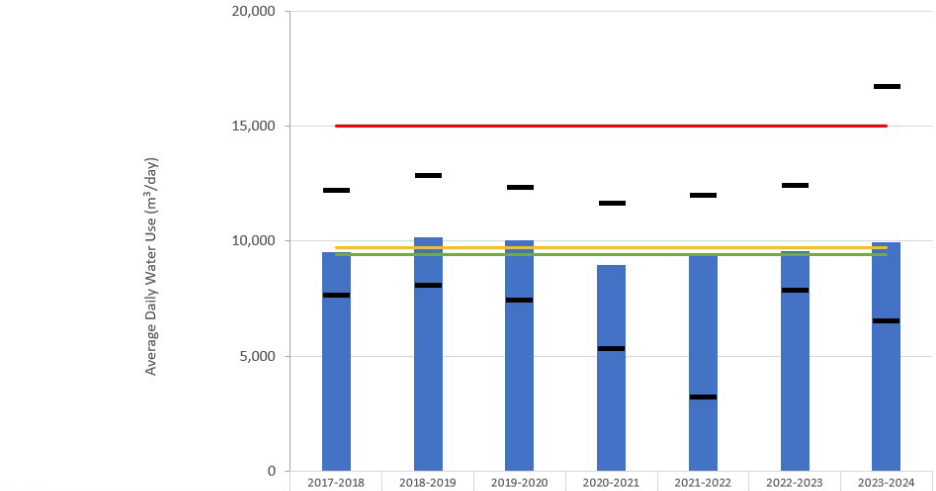
Present-Day "Reasonable and Justifiable Use" Assessment

The application of Policy LF-FW-P15 (4) in the present-day condition assumes that there is no allocation for future growth in section (g). Therefore in the present-day condition, an allocation for future growth is taken as 0 m³/ day.

The Total of Policy LF-FW-P15 (4) in the present-day ranges between 8,162 m³/ day - 8,396 m³/ day for sections (a) to (g). The final part of the assessment is to apply an allocation to account for water supply leakage.

Policy LF-FW-P15 (4) (h) applies a leakage estimate of 15% onto this total, which ranges from 1,224 m³/ day - 1,259 m³/ day.

The Policy LF-FW-P15 (4) "reasonable and justifiable use" for water allocation for the Levin public water supply is thereby estimated to be between 9,400 m³/ day to 9,700 m³/ day in the present-day. This is shown in Figure 1.



	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Average Water Demand (m³/day)	9,539	10,166	10,051	8,966	9,368	9,571	9,969
Minimum (m³/day)	7,608	8,052	7,417	5,281	3,186	7,810	6,487
Maximum (m³/day)	12,196	12,837	12,330	11,628	11,992	12,393	16,705
Policy LF-FW-P15 (4), Upper Estimate (m³/day)	9,700	9,700	9,700	9,700	9,700	9,700	9,700
Policy LF-FW-P15 (4), Lower Estimate (m³/day)	9,400	9,400	9,400	9,400	9,400	9,400	9,400
Levin Supply Consent Limit (m³/day)	15,000	15,000	15,000	15,000	15,000	15,000	15,000

Figure 1: Levin Water Supply Policy LF-FW-P15 (4) Assessment vs 2018 - 2024 Actual Water Demand (m³/ day)

Figure 1 shows the minimum and maximum daily water usage on the Levin water supply between 2018 - 2023 water years ranged between 3,186 - 12,837 m³/ day.

The absolute minimum daily consumption of 3,186 m^3/day in the 2022 water year occurred on a single day in mid-June 2022. The immediately preceding and following days were greater than double this minimum consumption of 9,040 and 7,940 m^3/day respectively. The next lowest daily consumption for the 2022 water year was almost double the minimum of 3,186 m^3/day, at approximately 7,200 m^3/day. This next minimum town supply demand of approximately 7,200 m^3/day is more reflective of the range of minimum consumption figures for the other 6 years, for the 2018 - 2024 water years.

The single day minimum of 3,186 m^3/day throughout the 7-year period is therefore considered to be an outlier data point.

For the most-recent 2024 water year, maximum daily consumption peaked at 16,705 m^3/day on 27 December 2023. This was the only occurrence, and for only a single day, where the daily consumption exceeded the Consent Limit of the Levin water supply on 15,000 m^3/day. However, it should be noted that the 15,000 m^3/day Consent Limit applies to the abstraction of water from the Ohau River, for treatment at the Levin Water Treatment Plant (WTP) and storage in reservoir tanks, to then supply to the town, not a limit of the town supply daily volume.

The maximum daily abstraction for the 2024 water year was 12,971 m^3/day a week earlier, on 19 December 2023. On 26 and 27 December 2023 the abstraction from the river was approximately 10,600 and 10,300 m^3/day respectively. The maximum daily town supply demand was therefore met by lowering the stored volume of treated water in the reservoirs at the Levin WTP. This maximum of 16,705 m^3 town supply demand does not represent a non-compliance with the water supply resource consent.

The next greatest daily consumption for the 2024 water year was 12,641 m^3 on 22 February 2024. This maximum town supply demand is more reflective of the range of maximum consumption figures for the preceding 6 years, for the 2018 - 2023 water years.

Likewise with the minimum daily town supply demand, the single day maximum of 16,705 m^3/day throughout the 7-year period is therefore considered to be an outlier data point.

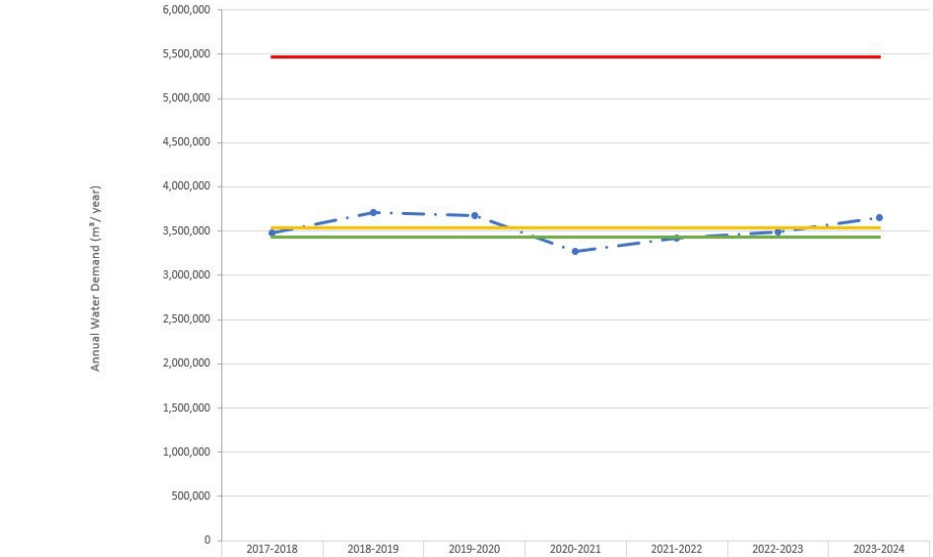
Therefore, by disregarding the absolute single minimum and maximum daily town supply demands, it can be considered that the town supply demand generally ranges between 5,300 - 12,800 m^3/day.

The Average (Daily) Water Demand ranged between 8,970 m^3/ day - 10,160 m^3/ day.

The average daily town supply demand on the Levin water supply network can be seen to generally reflect the range of this assessment for the Horizons One Plan Policy LF-FW-P15, section (4), determined herein to be between 9,400 - 9,700 m^3/day, as an estimate of what can be considered "reasonable and justifiable use" for water allocation for public water supplies within the Region.

Reflecting this in an Annual Water Demand framework, the actual Annual Water Use (Demand) on the Levin Water Supply between 2018 - 2024 water years can be compared against the upper and lower Policy LF-FW-P15 (4) estimates of 9,400 - 9,700 m^3/ day, which are average daily estimates, expressed as an annual allocation volume by multiplying by 365 days/ year. Figure 2 below shows the Annual Water Demand of Levin water supply against the Policy LF-FW-P15 (4) estimates, ranging from 3,431,000 m^3/ year - 3,540,500 m^3/ year.

Furthermore, as an indicator of the available supply volume of the core allocation, at a resource consent limit of 15,000 m^3/day, Figure 2 below shows the Levin Supply Consent Limit of 5,475,000 m^3/ year (by multiplication of the daily water abstraction limit of 15,000 m^3/day by 365 days/ year).



	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
Annual Water Use (m³/ year)	3,481,711	3,710,677	3,678,773	3,272,435	3,419,406	3,493,589	3,648,781
LF-FW-P15 (4), Lower Estimate	3,431,000	3,431,000	3,431,000	3,431,000	3,431,000	3,431,000	3,431,000
LF-FW-P15 (4), Upper Estimate	3,540,500	3,540,500	3,540,500	3,540,500	3,540,500	3,540,500	3,540,500
Levin Supply Consent Limit Estimate	5,475,000	5,475,000	5,475,000	5,475,000	5,475,000	5,475,000	5,475,000

Figure 2: Levin Water Supply Policy LF-FW-P15 (4) Assessment vs 2018 - 2024 Actual Water Demand (m³/ year)

Both Figure 1 and Figure 2 show that the actual water usage on the Levin water supply (when averaged across the year) is generally reflective of the estimated "reasonable and justifiable use" range determined by application of Policy LF-FW-P15 Section (4) of the Horizons Regional Council One Plan.

Future "Reasonable and Justifiable Needs" Assessment - Catering for Growth

Horizons Regional Council One Plan Policy LF-FW-P15 (4) section (g) introduces "*an allocation necessary to cater for growth, where urban growth of the municipality is provided for in an operative district plan for the area and is reasonably forecast*".

The potential increase in water demand of the Levin water supply, that may be considered as "reasonable and justifiable use" for the community in a projected future scenario, has not been determined by means of a specific allocation amount to be added onto the present-day water allocation assessment. Rather, the calculations made to assess the present-day allocation have been revisited with adjusted population figures for the community serviced by the Levin water supply network.

As stated by Policy LF-FW-P15 (4) (g), this may only be applied where urban growth is provided for in an operative district plan, and is reasonably forecast.

The Resource Consent being sought for the Levin Water Supply is for a period of 35 years, which extends to the year 2059. Horowhenua District Council has adopted the 95th percentile population estimates for planning purposes. As a sensitivity analysis, the median population projection has also been assumed, as per the Levin Water Supply Augmentation Options Framework report. The population in the year 2060 has been projected as follows:

- 95th percentile: 59,507 persons
- Median: 30,604 persons

The future assessment has been driven by a "Growth Population Scenario Ratio" whereby the increased population of that scenario is compared to the present-day registered population of the Levin drinking water supply, being 22,000 persons, such that the 95th percentile scenario of 59,057 persons has a ratio of 2.68:1 while the Median scenario of 30,604 persons has a ratio of 1.39:1.

It has been assumed that the increased population of the specific growth estimate being serviced by the Levin water supply has affected the Policy LF-FW-P15 (4) Assessment as follows:

a. Domestic needs have increased by growth ratio, either 2.68 or 1.139.

b. Commercial use has increased by growth ratio (being 20% of domestic needs).

c. Industrial use has remained unchanged, as the majority of population increase is projected to be urban and semi-urban, not water intensive industrial, within the supplied network. Within this allocation there is a range of estimate for Industrial use.

d. Public health, education and other facilities has increased by increasing the Schools and Marae allocation by the growth ratio, while Hospitals, NZ Defence Force and Corrections have remained at zero. Within this allocation there is a range of estimate for Schools.

e. Public amenity has increased by the growth ratio.

f. Animal/ Agricultural use has remained unchanged, as the majority of population increase is projected to be urban and semi-urban, not rural, within the supplied network. Within this allocation there is a range of estimate for Animal needs/ Agricultural use, from 0 m^3 - 37 m^3/ day.

g. The "allocation to cater for growth" is kept at zero, as the growth situation has been accounted for by the increased population, by multiplication of the present-day population by the "Growth Population Scenario Ratio.

h. The "allocation for leakage" remains constant at 15% of the sum of (i) to (vii).

Regarding the unchanged estimate of Animal needs/ Agricultural use, section (f), there is not a lot of certainty about this category of community water demand that can be applied from Council's operative District Plan.

The "Lifestyle" category of non-residential metered data in the present-day represents approximately 20% of the Total water consumption of non-residential metered connections.

As a relatively small component of the present-day water consumption, it has been assumed that estimating any change in this category of community water use will have only a minor effect on the overall assessment when compared with the level of uncertainty in the projected population figures between the 95th percentile and Median population scenarios. For this reason this component of the assessment has remained unchanged.

95th Percentile Growth "Reasonable and Justifiable Use" Assessment

The "Reasonable and Justifiable Use" for water allocation for the Levin public water supply is estimated to be between 24,900 m^3/ day to 25,300 m^3/ day by the expiry of the Levin water supply resource consent in the year 2060, under application of the 95th percentile growth scenario of Horowhenua District Council's Infrastructure Strategy with a projected growth population of 59,507 persons.

Median Growth "Reasonable and Justifiable Use" Assessment

The "Reasonable and Justifiable Use" for water allocation for the Levin public water supply is estimated to be between 13,000 m^3/ day to 13,300 m^3/ day by the expiry of the Levin water supply resource consent in the year 2060, under application of the Median growth scenario of Horowhenua District Council's Infrastructure Strategy with a projected growth population of 30,604 persons.

The Policy LF-FW-P15 (4) "reasonable and justifiable use" assessment, accounting for the reasonably forecast future growth of the Levin Water Supply network, is estimated to be between 13,000 m^3/ day - 25,300 m^3/ day by the year 2060.

CONCLUSION

The determination of Policy LF-FW-P15 (4) assessment for the Levin Water Supply Network, as per Horizons Regional Council's Regional Policy Statement (Part II of the One Plan) is that:

a. The present-day "reasonable and justifiable use" water allocation for the Levin public water supply is estimated to be between 9,400 m^3/ day to 9,700 m^3/ day. Actual water usage on the Levin public water supply (expressed as an annual average) is generally reflective of this estimate and therefore current water use can be considered to be reasonable and justifiable in accordance with Policy LF-FW-P15, section (4).

b. The future "reasonable and justifiable use" assessment of the Levin Water Supply network by application of Horowhenua District Council's Infrastructure Strategy population growth projections to the year 2060 is estimated to be between 13,000 m^3/ day - 25,300 m^3/ day at Median and 95th Percentile projection scenarios respectively.

Appendix D

HYDROLOGY ASSESSMENT

Ohau River

Poads Rd & LWTP Intakes

Modelled Annual Abstraction and Assessment of Effects on Flow

Prepared for:- Horowhenua District Council
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March 2023

Final report for consenting

Ohau River

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Limitation

This report has been prepared solely for the benefit of Horowhenua District Council 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.

The hydrological analyses, conclusions 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.

Third party data copyright statement

This work uses material (data) sourced from the Horizons Regional Council Hydrological Data Archive, which is licensed under a creative Commons Attributions 4.0 International licence by Horizons Regional Council.

The supply of flow records for Ohau R. at Rongomatane, Ohau R. at Rongomatane (naturalised flow), Ohau R. u/s Makahika confluence and Makahika Str. above Ohau confluence by NIWA and Horizons Regional Council and their kind permission to use the data in this study is acknowledged**.**

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EXECUTIVE SUMMARY

Horowhenua District Council (HDC) is developing an off-river raw water reservoir to provide a more resilient municipal water supply for Levin in the future.

HDC propose an intake at Poads Rd to fill a 740,000m^3 (approximate) raw water reservoir on land adjacent to the river. The new intake and the existing intake at the Levin WTP will operate flexibly to abstract the currently consented 15409m^3/day from the core allocation and use the intake at Poads Rd to take additional flow from a supplementary allocation when the river flow is above the median flow.

The naturalised flow record for the Ohau River at Rongomatane is extended through to 3rd October 2022. A daily water balance model was developed to calculate annualised abstraction volumes and assess the effect on the river flow regime. A limit of 7500m^3/day is abstracted at Poads Rd. intake (core allocation) plus an additional supplementary allocation amounting to 10% of the river flow when the river flow exceeds the median flow. The balance of consented flow from the core allocation (up to 8000m^3/day) is taken at the Levin WTP intake. The flow upstream of the Makahika confluence was estimated using a relationship based on concurrent flow gaugings and is assumed to be the flow at Poads Rd intake. The regulatory minimum flow and median flow at Poads Rd intake were scaled based on flow at Rongomatane using this relationship. No limitation has been placed on abstraction due to river turbidity and water storage volume has been assumed unlimited.

Abstraction from the core allocation roughly equates with the forecast average demand in 2039 (15,000m^3/day) assuming sufficient raw water storage, however in drier year sequences (1977, 1988, 1995, 2003 and 2021) there could be a significant shortfall. In these years the raw water in storage could be used to bridge this shortfall in conjunction with other treated water conservation measures.

Potential annual abstraction volumes from the supplementary allocation are more variable. When combined with the core allocation the potential abstraction volume is not sufficient to meet forecast demand in 2074 reliably. The accessible abstraction volume at both intakes should be assessed when a preliminary intake design has been completed for Poads Rd intake.

Flow duration, annual flood, mean annual low flow and FRE3 statistics at Poads Rd intake, Makahika confluence and Levin WTP intake were compared with naturalised flow statistics at those locations to assess the effect of the proposed scheme on the flow regime. At Poads Rd intake the effect of taking up to 7500m^3/day above the minimum flow and 10% of river flow when above the median flow is up to -15% change in flow, a 6% reduction in FRE3. The 1-day MALF reduces by 17%. A short distance downstream at the Makahika confluence these effects are reduced to up to -9% in flow, -4% in FRE3 and -11% in MALF. At Levin WTP the overall change in flow is up to 12%, -3% in FRE3 and -14% in MALF compared with the naturalised flow. During the summer low flow period (December to April) the effects are similar, even though there is less opportunity for abstraction from the supplementary allocation.

1 Introduction

Horowhenua District Council (HDC) is developing an off-river raw water reservoir to provide a more resilient municipal water supply for Levin in the future.

HDC has consent to take up to 15,409m^3/day for municipal water supply from the core allocation in the Ohau River at the Levin Water Treatment Plant (LWTP) intake and 750m^3/day for non-consumptive use. There is a provision to abstract up to 13,000m^3/day when flow in the Ohau River at Rongomatane is below minimum flow (Envir. Court 2014[1]).

HDC propose an intake at Poads Rd to fill a 740,000m^3 (approximate) raw water reservoir on land adjacent to the river (Figure 1). The addition of raw water storage at Poads Rd will allow a flexible abstraction arrangement from the core allocation using both intakes and an additional volume of flow taken at Poads Rd intake from a supplementary flow allocation in the river above the median flow. Water from the reservoir will be used to supplement existing abstraction for the water treatment plant when river flow is either too low or is not suitable for direct pumping to the plant.

The infrastructure planning horizon is 50 years when the current average daily demand of about 10,000m^3/day demand is forecast to increase to about 15,000m^3/day in 2039 and 35,000m^3/day in 2074 (GEML 2022[2]).

The scope of this report is to outline the hydrology of the river, model the annual abstraction volumes at Poads Rd and Levin WTP intakes and assess the effects of the proposed flexible intake arrangement on river flow at locations on the river downstream of the Poads Rd intake.



Figure 1 Location map for key locations upstream of the Levin water treatment plant.

[1] Envir. Court (2017) Consent Order dated 15th May 2017 issued by Environment Court Judge B P Dwyer, Environment Court Wellington.
[2] GEML (2022) *Levin Water Supply Water Supply Augmentation Operational Framework (June 2022)* prepared for Horowhenua District Council by Good Earth Matters Consulting Limited, 36p.

2 Catchment description

The Ohau catchment is located to the southeast of Levin and has an area of about 180km^2 although downstream of Rongomatane the watershed boundary is diffuse and difficult to define across the coastal plain. The surface water and groundwater on the coastal plain can be viewed as one interconnected system.

The watershed extends to an elevation of about 1100m in the Tararua Ranges and has a mean annual rainfall of 1825mm (1961-90). The catchment has a large rainfall gradient that varies from 800mm at the coast to about 2600mm at the top of the catchment.

The Levin WTP is located a short distance downstream from the Regional Council flow gauge at Rongomatane where the river exits the ranges and flows over the coastal plain. Above Rongomatane the mean annual rainfall is 2260mm (HRC 2003)[3]. The naturalised mean flow of the Ohau River at Rongomatane is 6.58m^3/s (1974-2022).

Three greywacke hill country catchments converge upstream of Rongomatane (Makahika, upper Ohau and Makaretu catchments), and are for the most part vegetated in native forest although the Makahika has more area in plantation forest and pasture. The combined area of the three catchments is about 104km^2.

Downstream from Rongomatane, the main stem of the river flows across a coastal plain which comprises outwash sedimentary deposits. The main tributaries on the coastal plain are the Makorokoi and Kuku Streams, which have headwaters in native forested coastal foothills. The dominant land use is pastoral and cropping on the plain and native forest in the headwaters. While the lower Ohau river picks up additional flow from several tributaries, the interaction between the surface water bodies and with the underlying aquifer results in reaches with gains, losses or stable flow downstream from the HDC water treatment plant. During several dry summers significant stretches of dry river bed have been observed downstream of the State Highway, as occurred in the extreme dry summer in February 2003 (HRC 2003).

3 Hydrological information

The principal flow record on the Ohau River is located in the area near Gladstone Reserve and Rongomatane upstream from the current LWTP intake beginning in January 1974 (Table 1). A short flow record was collected at Muhunoa East Rd between April 1972 and March 1976. Flow on the lower reaches of the river has been recorded at Haines Ford since December 2015. Periodically longitudinal flow gauging surveys have been conducted since 1974 by NIWA and Horizons Regional Council and more recently state of the environment flow measurements. An automatic rain gauge has operated at Makahika since December 2009. A daily manual rain gauge operated from July 1959 until December 1982.

In 2003 Horizons Regional Council constructed a naturalised flow dataset for the river flow at Rongomatane. The naturalised flow record at Rongomatane has been used in this study.

[3] HRC (2003) Water Allocation Project, Ohau River Water Resource Assessment, Allocation Limits and Minimum Flows, technical report to support policy development prepared by the Environmental Information Team, Horizons Regional Council, Palmerston North, November 2003, Report No. 2003/EXT/575, 89p

3.1 Ohau at Rongomatane naturalised flow series

A flow gauge was operated by NIWA at Gladstone Reserve until 1978 when the current flow gauge site at Rongomatane was established. Horizons Regional Council (HRC) took over the operation of the Rongomatane flow gauge in 2011 and this flow record has been used to regulate surface water takes on this part of the Ohau River. The flow record is well supported by regular flow gaugings and can be considered reliable.

The historical Ohau River flow record at Rongomatane has been affected by abstraction related to the Levin Water Supply at various times and from two locations. Before 1 July 1995 flow diverted at the old HDC water supply intake u/s of Poads Road bypassed the river flow gauges. Later, from 1978 until March 2002, flow diverted into the Ohau Water Race immediately downstream of the earlier Ohau at Water Race flow gauge was not recorded at the current site at Rongomatane. A naturalised flow dataset in which the diverted flows above are added to the recorded river flows was assembled for the Ohau River Flow Allocation Project (HRC 2003).

The naturalised flow series (1974-2003) was used as the basis for setting the Minimum Flow and Core Allocation for the catchment at Rongomatane and for assessing the effect the core allocation had on the flow regime along the length of the river between Poads Road and the river mouth.

18-Feb-1974 to 15-Jul-1978	This period is calculated using flow recorded at the Ohau at Water Race site with the estimated abstraction rate from the Levin Water Supply at Poads Road take added to it.
15-Jul-1978 to 6-Mar-1991 10:00	Estimated Poads Road take and estimated Water Race diversion flows are added to the recorded Rongomatane flow.
6-Mar-1991 10:00 to 1-Jul-1995	Use of the Poads Road intake is estimated to have ceased on 1 Jul 1995. Estimated Poads Road take and recorded Water Race diversion flows are added to recorded Rongomatane flow.
1-Jul-1995 10:00 to 26-Feb-1997 13:30	The flow in the Water Race was recorded at Ohau [Water Race] at d/s culvert until 26-Feb-1997. Recorded Ohau [Water Race] at d/s culvert flow is added to the recorded Ohau at Rongomatane flow.
26-Feb-1997 13:30 to 1-Mar-2002 00:00	The Water Race is estimated to have ceased operation on 1 March 2002. Naturalised flow is estimated as recorded Ohau at Rongomatane flow plus the estimated diversion of flow into water race.
1-Mar-2002 00:00:00 to 16-Apr-2003 15:30	Levin's public water supply is drawn from downstream of Rongomatane. The Ohau at Rongomatane flow as recorded is the natural flow.
16-Apr-2003 15:30 to 2022	Levin's public water supply is drawn from downstream of Rongomatane. The Ohau at Rongomatane flow as recorded is the natural flow.

Table 1 Summary of method used to derive the Ohau at Rongomatane naturalised flow record (after HRC 2003).

The naturalised flow record at the Rongomatane flow gauge was constructed by combining the historical flow records at Gladstone Reserve and Rongomatane and adding back into those the flow abstracted at the old HDC intake at Poads Rd. and flow diverted to the Levin water treatment plant downstream of flow recorder at Gladstone Reserve (Table 1).

There are 17 periods of missing data in the historical and naturalised historical flow records and ranging in duration from 1.2 to 23.2 days. The gaps in the data do not significantly affect the overall flow statistics.

The 2003 version of the flow dataset was obtained from Horizons Regional Council and for this study has been extended using the Rongomatane flow record which has been the natural river flow since March 2002.

The flow regime in the Ohau River is strongly influenced by rainfall events and there is little base flow in the river. During winter and spring, the flow in the river can be highly variable due to the frequent passage of storms whereas in summer and autumn months when rainfall is less frequent the flow in the river can recede to low levels over several weeks until the next significant storm event and associated flood to refresh the river.

3.2 Upper Ohau and Makahika flow relationships

Concurrent flow gaugings have been carried out by NIWA and HRC at Rongomatane and various other locations on the river including on the Makahika Stream and Ohau River at their confluence (Table 2).

Concurrent flow gaugings after March 2002, which measured the natural river flow, have been used to derive linear regression correlations for flow in the Ohau River and Makahika Stream upstream of their confluence for use with the naturalised flow at the Rongomatane gauge (Figure 2).

Site name	Area (km^2)	Records
Ohau R. at Rongomatane (naturalised flow)	105	Flow record (18/1/74 to 4/10/2033) adding in diverted flow at old Poads Rd intake and Ohau Water Race
Ohau R. u/s Makahika Confluence	36.5	22 flow gaugings, 18 concurrent with Rongomatane
Makahika Str. Above Ohau Confluence	40.6	51 flow gaugings, 30 concurrent with Rongomatane

Table 2 Hydrological data used for this study.

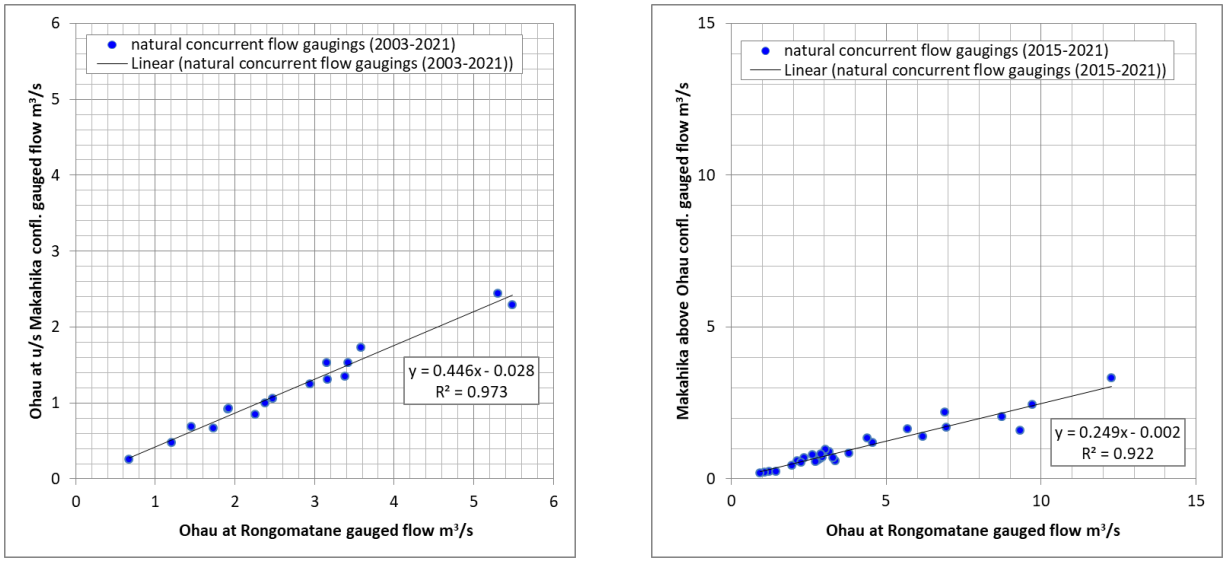


Figure 2 Linear regression correlations for same day flow gaugings used to estimate flow on the Ohau River (left) and Makahika Stream (right) upstream of their confluence.

The regression relationships are;

Ohau R. u/s Makahika Confluence (m^3/s) = 0.446 x naturalised Rongomatane flow - 0.028 (r^2=0.97)

Makahika Str. above Ohau Confluence (m^3/s) = 0.249 x naturalised Rongomatane flow - 0.002 (r^2 = 0.92)

The naturalised flow record for the Ohau R. u/s Makahika confluence is representative of the flow at the location of a proposed Intake at Poads Road, about 800m upstream from the gauging location (Figure 1).

4 The Water Balance Model

A water balance model was written in Hilltop VSIM and the sole data input is the daily mean naturalised river flow at Rongomatane. The structure of the model is shown in Figure 3 below.

Flow in the Ohau River at the Poads Rd intake, and in the Makahika Stream upstream of the Ohau confluence and equivalent minimum and median flows at the Poads Rd intake are calculated using the above relationships.

The median flow threshold used in the model to regulate the water take in the supplementary allocation is the 1974-2003 flow statistics to be consistent with the current regulatory minimum flow at Rongomatane (Table 3).

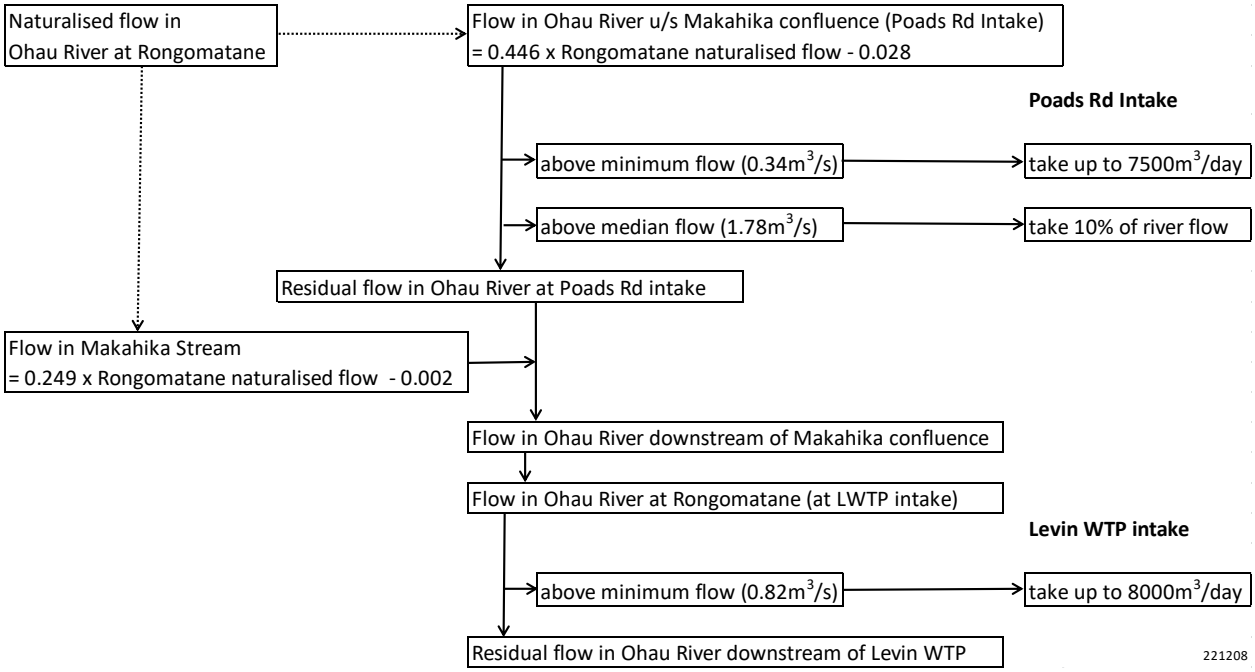


Figure 3 Outline of Daily Water Balance Model

	Flow (m^3/s)	
	Minimum flow	Median flow
Ohau at Rongomatane	0.82	3.86
Ohau at Poads Rd intake	0.34	1.69

Table 3 Minimum and median flow values (1974-2003) used in the water balance model.

The capacity of Poads Rd intake is set as up to 7500m^3/day and the Levin WTP intake up to 8000m^3/day when flow is above the minimum flow. The latter capacity is set by the preferred operating scenario for the existing intake at the water treatment plant.

No constraint has been applied concerning available storage, nor limitation on the takes due to high river turbidity. The capacity of the treatment plant is limited when raw water turbidity is elevated.

The following analysis is based on assumed intake capacities at Poads Rd intake and the water treatment plant for abstracting from the core allocation and unlimited capacity at Poads Rd intake abstraction from the supplementary allocation at Poads Rd intake.

The potential abstraction each day is calculated above the minimum flow at Poads Rd and the balance available from river flow on the day at the Levin WTP and the combined take is capped at 15,409m^3/day. The current consent condition allowing 13,000m^3/day to be abstracted when the flow is below the minimum flow has not included in the model.

The potential abstraction from the supplementary flow allocation at the Poads Rd intake is calculated when the river flow there is above the median flow and amounts to 10% of the river flow.

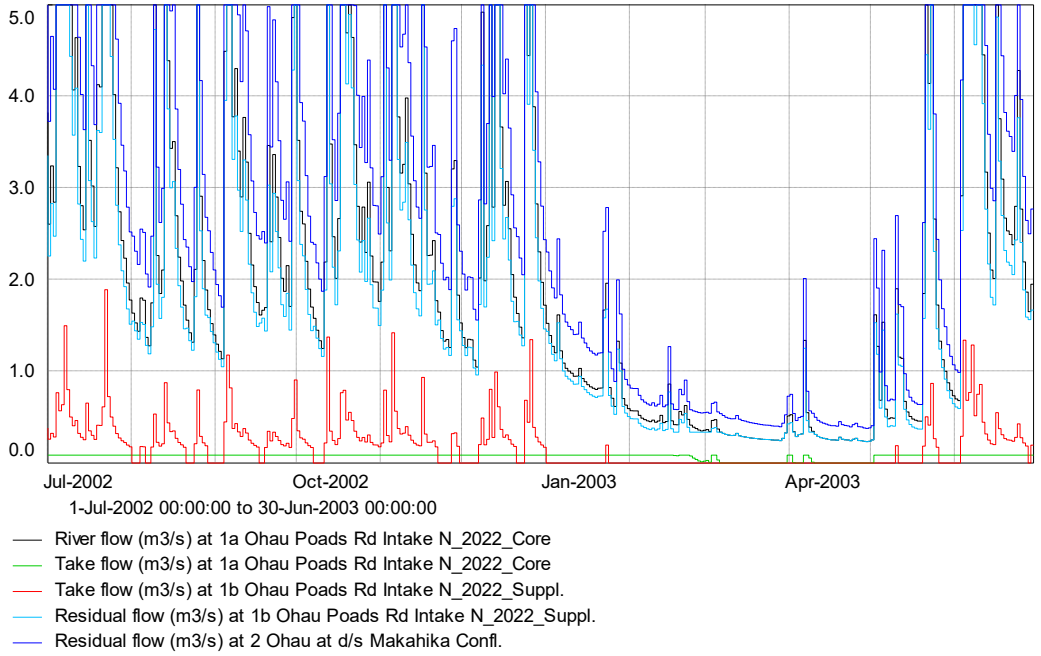


Figure 4 Modelled flows in daily water balance model between Poads Rd intake and downstream from Makahika confluence (December 2002 to June 2003).

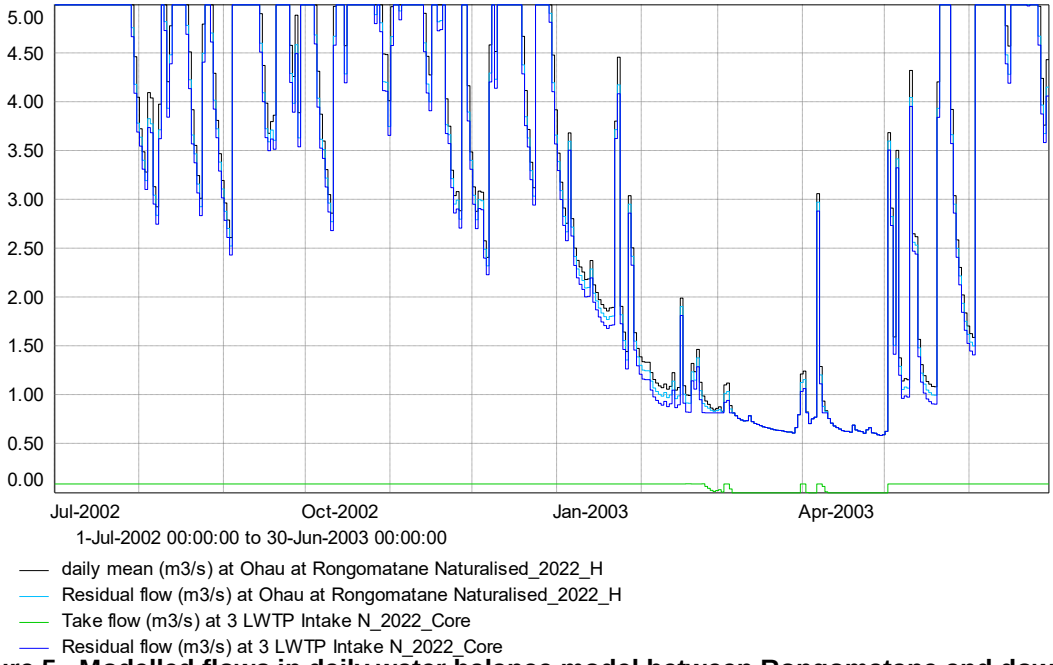


Figure 5 Modelled flows in daily water balance model between Rongomatane and downstream from Levin WTP intake (December 2002 to June 2003).

The residual river flow at Poads Rd intake, downstream of the Makahika confluence, and downstream of the Levin WTP are calculated. A set of output from the model at the Poads Rd intake is shown in Figure 4 and at the Levin WTP intake in Figure 5.

5 Annualised Abstraction Volume

Based on the available 48-year flow record (1974 to 2022) the potential annual abstraction volume for complete data years has been calculated for each intake (core allocation, supplementary allocation, and the combined total). The abstraction volumes (July-June year) for complete data years are listed in Table 4. The same data is plotted in Figure 6.

The years 1989, 1995 and 1996 contain gaps in data that in aggregate amount to less than 15 days and underestimate volumes slightly. The years 1991, 1993 and 1994 are excluded from the results because these years contain individual data gaps exceeding 15 days which in aggregate amount to between 19 and 52 days.

Potential abstraction from the core and supplementary allocations are compared in Figure 7 with the forecast annual demand volumes in 2039 and 2074 (GEML 2022)[4]. The forecast demand in 2039 is estimated to be on average 15,000m^3/day and in 2074 is 35,000m^3/day. Abstraction from the core allocation roughly equates with the forecast demand in 2039 assuming sufficient raw water storage however, in drier year sequences (1977, 1988, 1995, 2003 and 2021) there could be a significant shortfall. In these years the raw water in storage could be used to bridge this shortfall in conjunction with other treated water conservation measures.

Potential annual abstraction volumes from the supplementary allocation are more variable. When combined with the core allocation the potential abstraction volume is not sufficient to meet forecast demand in 2074 reliably.

The accessible abstraction volume at both intakes should be assessed when a preliminary intake design has been completed for Poads Rd intake.

6 Assessment of effects on flow

The effect on Ohau River flow at Poads Rd intake, Makahika confluence and downstream of the Levin WTP is summarised in Figure 5 for Ohau at Poads Rd intake and Table 6 for Ohau d/s Makahika confluence and downstream of Levin WTP.

In each table, the incremental and cumulative change for a range of modelled flow statistics has been presented and compared with the naturalised river flow at each location. Average flow duration statistics, the mean annual flood, 3x median flow daily mean annual low flow and minimum flow changes are presented.

At Poads Rd intake the effect of taking up to 7500m^3/day above the flow level equivalent to the minimum flow at Rongomatane results in a less than 10% reduction in minimum flow, mean flow, upper and lower quartile flows, median flow and FRE3[5]. 1-day MALF reduces by 17%.

[4] GEML(2022) Levin Water Supply – Water Supply Augmentation Operational Framework (Draft for Project Team Review) May 2022, prepared for Horowhenua District Council by Good Earth Matters Consulting Limited.

[5] FRE_3 is the annual frequency of flushing flow events (flow events exceeding 3x median flow)

	Abstraction from Core Allocation (m^3/1000)		Abstraction from Allocation (m^3/1000)		
Year	Poads Rd	Levin WTP	Core	Supplementary	Total
1973 / 1974					
1974 / 1975	2631	2781	5412	6688	12100
1975 / 1976	2745	2895	5640	7645	13285
1976 / 1977	2738	2887	5624	8002	13626
1977 / 1978	2497	2647	5144	5071	10215
1978 / 1979	2738	2887	5624	7949	13574
1979 / 1980	2745	2895	5640	9500	15140
1980 / 1981	2738	2887	5624	8445	14069
1981 / 1982	2722	2873	5595	5819	11414
1982 / 1983	2738	2887	5624	8564	14188
1983 / 1984	2745	2895	5640	7571	13211
1984 / 1985	2679	2843	5522	5040	10561
1985 / 1986	2738	2887	5624	6465	12089
1986 / 1987	2681	2829	5510	7084	12594
1987 / 1988	2740	2892	5631	5747	11378
1988 / 1989	2505	2648	5153	8253	13406
1989 / 1990	2729 ?	2884 ?	5613 ?	6315 ?	11928 ?
1990 / 1991	2738	2887	5624	8303	13927
1991 / 1992					
1992 / 1993	2738	2887	5624	8994	14618
1993 / 1994					
1994 / 1995					
1995 / 1996	2595 ?	2737 ?	5332 ?	8838 ?	14170 ?
1996 / 1997	2692 ?	2839 ?	5532 ?	7259 ?	12791 ?
1997 / 1998	2738	2887	5624	8747	14372
1998 / 1999	2733	2886	5619	8724	14343
1999 / 2000	2745	2895	5640	6794	12434
2000 / 2001	2738	2887	5624	5708	11332
2001 / 2002	2738	2887	5624	8065	13689
2002 / 2003	2303	2434	4737	6352	11090
2003 / 2004	2745	2895	5640	9789	15429
2004 / 2005	2738	2887	5624	9100	14725
2005 / 2006	2738	2887	5624	5260	10885
2006 / 2007	2738	2887	5624	8972	14597
2007 / 2008	2710	2868	5578	5117	10694
2008 / 2009	2708	2863	5572	8877	14449
2009 / 2010	2720	2875	5595	7082	12677
2010 / 2011	2738	2887	5624	7468	13092
2011 / 2012	2745	2895	5640	6565	12204
2012 / 2013	2732	2887	5619	5046	10665
2013 / 2014	2732	2886	5619	6436	12055
2014 / 2015	2725	2877	5602	8269	13871
2015 / 2016	2745	2895	5640	8182	13822
2016 / 2017	2738	2887	5624	12837	18461
2017 / 2018	2650	2803	5453	7234	12688
2018 / 2019	2738	2887	5624	6154	11779
2019 / 2020	2745	2895	5640	6935	12575
2020 / 2021	2728	2882	5610	9123	14733
2021 / 2022	2563	2716	5279	8419	13698
Min	2303	2434	4737	5040	10215
Mean	2701	2851	5552	7529	13081
Max	2745	2895	5640	12837	18461

The Min Mean and Max of Annual values are for complete years only.
This table was produced with a gap tolerance of 360.0 hours.
There were 19 gaps in the data and 16 of these were within the gap tolerance.
? Indicates incomplete years data

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Table 4 Modelled potential annual abstraction volumes for complete data years at each intake from the core and supplementary allocations, and the combined total.

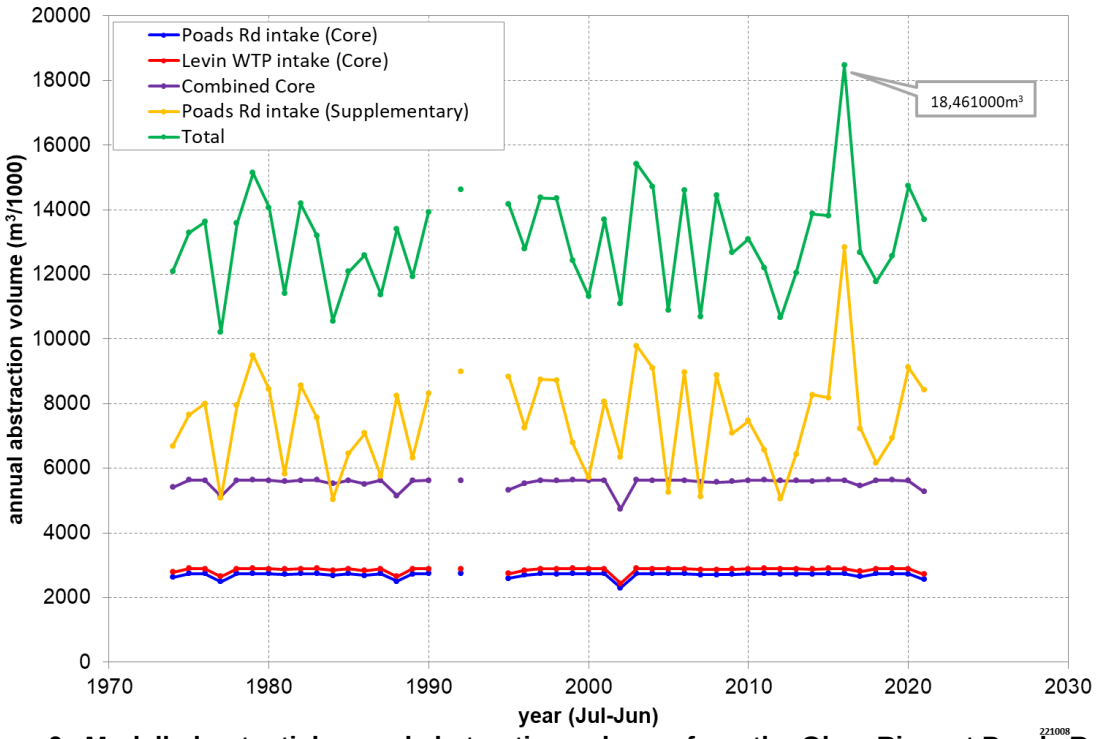


Figure 6 Modelled potential annual abstraction volumes from the Ohau River at Poads Rd and Levin WTP intakes (1974-2022).

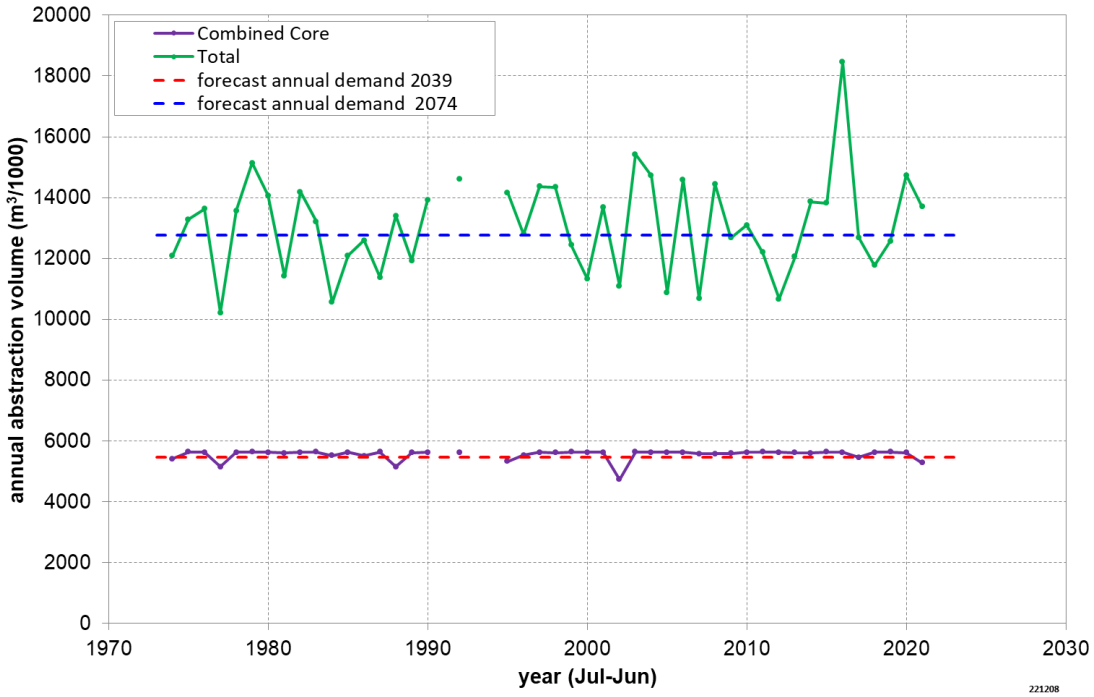


Figure 7 Forecast future demand (GEML 2022) compared with modelled combined core and total annual abstraction volumes from the Ohau River at Poads Rd and Levin WTP intakes (1974-2022).

The scale of these flow regime changes is consistent with the flow regime change at Rongomatane (Keane 2022)[6].

[6] Keane, A J (2022) *Ohau River Supplementary Flow Allocation Report, Draft 3 Nov 2022*, prepared for Horowhenua District Council by Keane Associates Ltd, Upper Hutt.

The incremental change due to abstraction of the full supplementary allocation when the flow is above the median flow level equivalent to the median flow at Rongomatane the incremental change in the flow statistics above the median flow is 10 to 11%.

	Percent time flow exceeded	Naturalised flow (m^3/s)	Naturalised flow minus core allocation (m^3/s)	Change from naturalised flow (%)	Supplementary Flow Allocation [Policy 5-17 ; 10% of actual river flow] (m^3/s)	Naturalised flow minus core & supplemnetary allocation (m^3/s)	Incremental change from naturalised flow minus core allocation (%)	Cumulative percentage change from naturalised flow (%)
	0	82.0	81.9	-0.1	8.2	73.7	-10	-10
mean annual flood		36.7	36.6	-0.2	3.67	33.0	-10	-10
	10	5.92	5.84	-1.5	0.59	5.25	-10	-11
3x median flow		5.32	5.06	-4.9	0.53	4.53	-11	-15
	20	3.79	3.70	-2.3	0.38	3.32	-10	-12
	25	3.21	3.12	-2.8	0.32	2.80	-10	-13
	30	2.80	2.71	-3.1	0.28	2.43	-10	-13
	40	2.19	2.10	-3.9	0.22	1.89	-10	-14
median flow	50	1.774	1.69	-4.9	0.18	1.56	-8	-12
	60	1.45	1.37	-6.0	0	1.37	-0.1	-6.1
	70	1.19	1.10	-7.3	0	1.10	0	-7.5
	75	1.06	0.97	-8.1	0	0.97	0	-8.1
	80	0.93	0.84	-9.6	0	0.84	0	-10
	90	0.67	0.59	-13	0	0.59	0	-13
1d-MALF		0.44	0.36	-17	0	0.36	0	-17
minimum flow		0.34	0.34	0	0	0.34	0	0
	100	0.23	0.23	0	0	0.23	0	0
Mean		2.88	2.79	-3.0	0.24	2.56	-9	-11
Std Dev		3.79	3.79	0.0	0.41	3.39	-11	-11
FRE3		14.3	14.2	-0.4		13.4	-6.0	-6.4

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Table 5 Effect of modelled abstraction on Ohau River flow at Poads Rd intake (1974-2022).

	Percent time flow exceeded	flow at d/s Makahika confluence (m^3/s)	Ohau d/s Makahika Confluence (m^3/s)	Change from naturalised flow (%)	Naturalised flow at Rongomatane (m^3/s)	Residual flow Ohau d/s LWTP (m^3/s)	Change from naturalised flow (%)
	0	128	119	-6.5	184	175	-4.6
mean annual flood		57.2	54.5	-4.8	82.4	78.5	-4.7
	10	9.21	8.57	-7.0	13.3	12.6	-5.5
3x median flow		8.38	7.63	-9.0	12.1	11.1	-8.3
	20	5.90	5.45	-7.6	8.53	8.00	-6.2
	25	5.00	4.61	-7.9	7.24	6.76	-6.6
	30	4.36	4.01	-8.2	6.32	5.88	-7.0
	40	3.42	3.12	-8.7	4.96	4.58	-7.8
median flow	50	2.774	2.54	-8.3	4.03	3.70	-8.3
	60	2.28	2.19	-3.7	3.32	3.14	-5.4
	70	1.87	1.78	-4.7	2.73	2.55	-6.6
	75	1.66	1.57	-5.3	2.43	2.25	-7.4
	80	1.47	1.37	-6.3	2.15	1.97	-8.6
	90	1.07	0.98	-8.8	1.59	1.40	-12
1d-MALF		0.69	0.62	-11	1.04	0.89	-15
minimum flow		0.54	0.54	0	0.82	0.82	0
	100	0.38	0.38	-0.2	0.59	0.59	0
Mean		4.50	4.18	-7.2	6.52	6.10	-6.3
Std Dev		5.89	5.51	-6.5	8.52	8.10	-4.9
FRE3		14.3	13.7	-3.6	14.2	13.8	-3.0

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Table 6 Effect of modelled abstraction on Ohau River flow at Makahika confluence and Levin WTP Rd intake (1974-2022).

The change in FRE3 due to abstraction in the core allocation is <1% and the cumulative effect including abstraction in the supplementary allocation is 7%. The cumulative effect downstream of the intake is a change in flow of up to -15%, MALF by -17% and FRE3 by -6% compared with the naturalised flow.

The confluence with the Makahika Stream is about 800m downstream from the Poads Rd intake and contributes about 25% of the natural flow at Rongomatane compared with 45% from the upper Ohau River. The addition of natural flow from the Makahika reduces the effect of abstraction at Poads Rd intake on Ohau River flow from this point downstream. In all cases, the percentage change in flow d/s of Makahika confluence when compared with the naturalised flow in Table 6 is less than at effect at the Poads Rd intake in Table 5. The flows change by up to -9%, MALF by -11% and FRE3 by -4%.

Downstream from the Levin WTP intake, the effect on flow change below median flow is the same as under the current consent conditions, up to -12% and MALF changes by -15%. Above the median flow, including the effect of the supplementary allocation, the flow change is up to -8%. The change is FRE3 is -4%. Downstream from the Levin WTP, the effect from abstraction in the supplementary flow allocation is similar to that below median flow due to abstraction from the core allocation. Overall the flow changes up to – 12%, MALF by -15% and FRE3 by -3%.

	Percent time flow exceeded	Naturalised flow at Poads Rd Intake (m^3/s)	Naturalised flow minus core & supplemnetary allocation (m^3/s)	Change from naturalised flow (%)	Naturalised flow at d/s Makahika confluence (m^3/s)	Residual flow Ohau d/s Makahika Confluence (m^3/s)	Change from naturalised flow (%)	Naturalised flow at Rongomatane (m^3/s)	Residual flow Ohau d/s LWTP (m^3/s)	Change from naturalised flow (%)
	0	81.97	73.68	-10	128	119	-6.5	183.84	175	-4.6
	10	4.69	4.16	-11	7.4	6.80	-7.7	10.65	10	-6.2
	20	2.81	2.46	-13	4.4	4.05	-8.3	6.40	5.94	-7.1
	25	2.36	2.05	-13	3.7	3.39	-8.7	5.39	4.97	-7.7
	30	2.02	1.74	-14	3.2	2.90	-9.0	4.62	4.24	-8.2
	40	1.58	1.47	-6.7	2.5	2.40	-3.7	3.63	3.45	-5.1
median flow	50	1.27	1.20	-5.9	2.0	1.93	-4.1	2.94	2.77	-5.8
	60	1.04	0.96	-7.5	1.6	1.56	-5.2	2.41	2.23	-7.4
	70	0.84	0.77	-9.4	1.3	1.25	-6.6	1.97	1.79	-9.2
	75	0.76	0.68	-10	1.2	1.13	-7.0	1.78	1.61	-9.9
	80	0.68	0.60	-12	1.1	1.00	-7.8	1.60	1.43	-11
	90	0.52	0.44	-16	0.8	0.75	-10	1.25	1.07	-14
minimum flow		0.34	0.34	0	0.5	0.54	0	0.82	0.82	0
	100	0.23	0.23	0	0.38	0.38	-0.2	0.59	0.59	0
Mean		2.30	2.06	-11	3.63	3.37	-7.1	5.26	4.91	-6.6
Std Dev		3.61	3.24	-10	5.62	5.26	-6.3	8.13	7.74	-4.7

Table 7 Effect of modelled abstraction during summer low flow period on Ohau River between Poads Rd intake at Levin WTP Rd intake (1974-2022).

The percentage changes in flow statistics during the summer low flow period (December and April) at points downstream of Poads Rd intake are shown in Table 7. When the percentage changes are compared with those for the annual statistics in Table 5 and Table 6 the changes confluence by up to 10% and downstream form the Levin WTP by up to 14%.

Modelled river flow duration curves upstream and downstream of the Poads Rd intake are shown in Figure 5. Naturally occurring summer low flow events can extend through into April. The flow duration curve for the months of December to April inclusive is compared with the annual flow duration curve. This shows that at Poads Rd intake, on average, during these summer and autumn months the amount of water able to be abstracted from the river represented by the area between red and blue lines is small compared with the rest of the year.

Similarly in Figure 6 the modelled river flow duration curves upstream and downstream of the Levin WTP are shown. During the summer to autumn period, the flow available to be abstracted is greater, mainly because at the Levin WTP intake the scale of river flow is about twice the flow at Poads Rd.

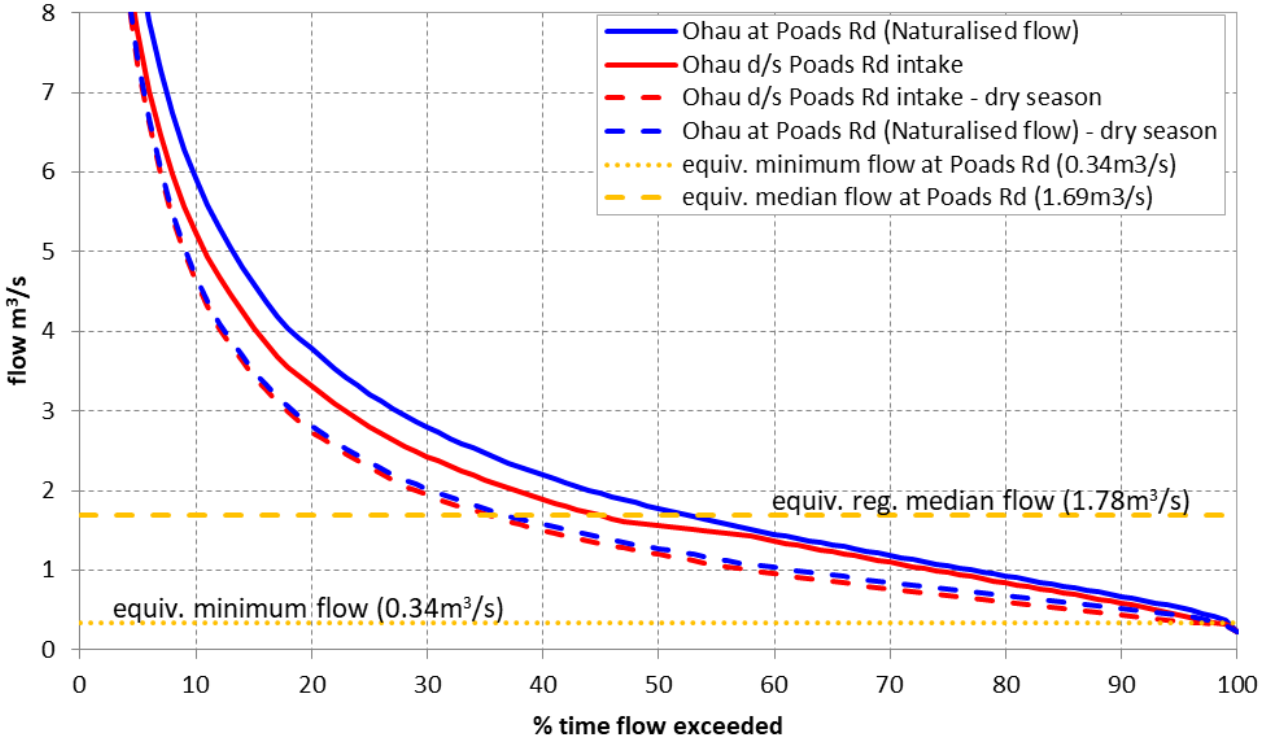


Figure 8 Flow duration curves (0-8m3/s) for modelled flow upstream and downstream of Poads Road intake.

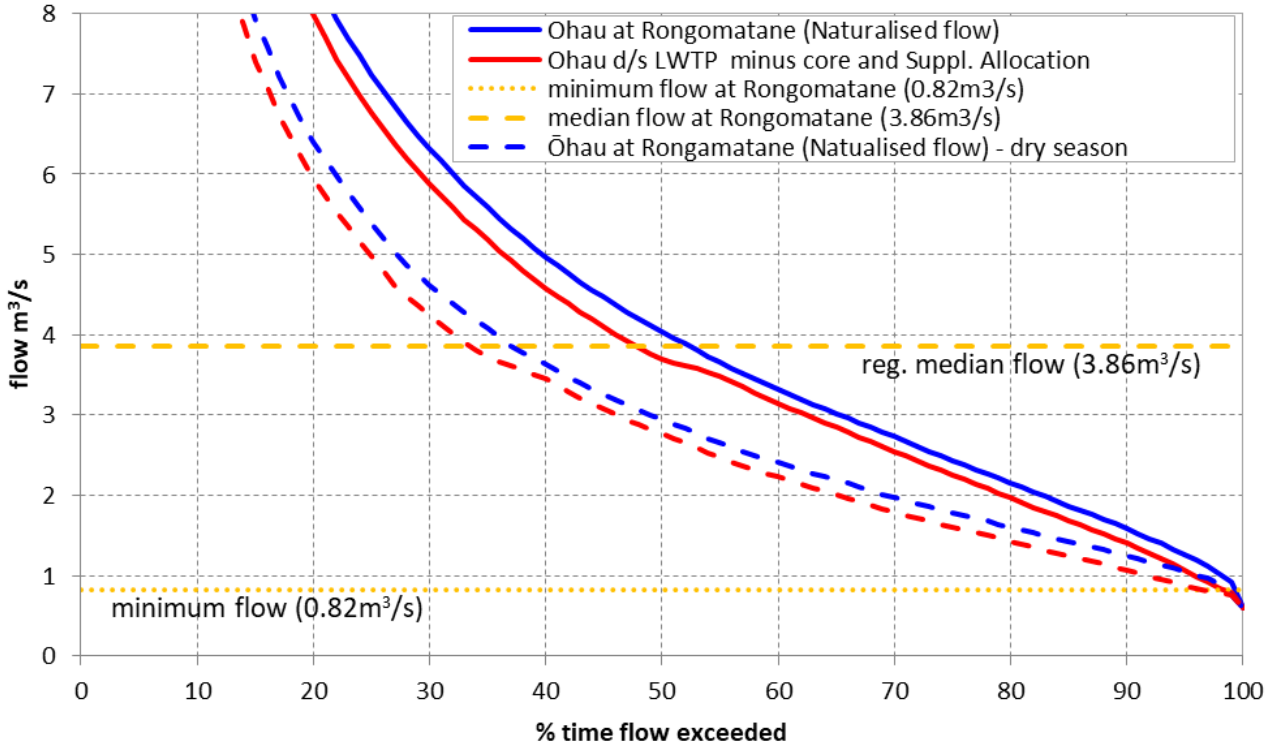


Figure 9 Flow duration curves (0-8m3/s) for modelled flow upstream and downstream of the Levin WTP intake.

In both figures, the inflection in the shape of the flow duration curves at about median flow is due to the additional flow abstracted in the supplementary allocation at Poads Rd intake. While it is proposed to take flow from the river upstream of the current Levin WTP intake, the effect of abstraction on flows downstream of the Levin WTP when the flow is below the median flow is consistent with the previously assessed effect (HRC 2003).

The effect of adding a supplementary allocation has been assessed recently (Keane 2022). Horizons Regional Council carried out several longitudinal flow surveys between Poads Rd and Haines Ford between 1974 and 2003 when flow at Rongomatane has been below 1.4m^3/s (HRC 2003). When above about 1m^3/s, flow in the Ohau River is assumed to flow continuously past SH1 bridge through to the Haines Ford and the river mouth. When the river is flowing above its median flow (e.g. 3.8m^3/s at Rongomatane), and the additional flow from the Makorokoi and Kuku Streams is considered along with continuing flow losses from the surface water bodies to the underlying aquifer, a reduction in flow due to the additional supplementary abstraction at Poads Rd intake is not likely to alter the existing flow in the lower reaches of the river by more than a few percent.

7 Summary and Conclusions

Horowhenua District Council (HDC) is developing an off-river raw water reservoir to provide a more resilient municipal water supply for Levin in the future. Potential abstraction volumes from the proposed scheme involving flexible abstraction in the core allocation at Poads Rd (7500m^3/day) and Levin WTP (8000m^3/day) intakes and additional flow in the supplementary allocation taken at Poads Rd has been modelled with no constraint on storage or due to high turbidity river flow.

Abstraction from the core allocation roughly equates with the forecast average demand in 2039 (15,000m3/day) assuming sufficient raw water storage, however in drier year sequences (1977, 1988, 1995, 2003 and 2021) there could be a significant shortfall. In these years the raw water in storage could be used to bridge this shortfall in conjunction with other treated water conservation measures.

Potential annual abstraction volumes from the supplementary allocation are more variable. When combined with the core allocation the potential abstraction volume is not sufficient to meet forecast demand in 2074 reliably.

At Poads Rd intake the effect above the minimum flow and above the median flow is a change of up to -15% in flow, a reduction in FRE3 by 6% and a reduction in 1-day MALF by 17% compared with the naturalised flow. A short distance downstream at the Makahika confluence these effects are reduced, being up to -9% in flow, -4% in FRE3 and -11% in MALF. At the Levin WTP the overall change in flow is up to -12%, in FRE3 by -3% and in MALF by -15%. During the summer low flow period (December to April) the effects are similar, even though there is much less opportunity for abstraction from the supplementary allocation.

This assessment assesses the potential abstraction and maximum effects. The accessible abstraction volume at both intakes should be assessed when a preliminary intake design has been completed for Poads Rd intake. The actual effects are likely to be slightly less than presented here.

Appendix A Monthly flow tables

Poads Rd Intake
~~~ Hilltop Hydro ~~~ Version 6.73 14-Dec-2022
~~~ PCAL ~~~

Source is E:\!Projects\P56A Poads Rd Intake Consenting\Stg3 Consenting Assessment of Effects\Results for Peer review\Data - 2takes - 7Dec22.hts
River flow (m3/s) at 1a Ohau Poads Rd Intake N_2022_Core
From 18-Feb-1974 00:00:00 to 3-Oct-2022 24:00:00

Monthly Means 1974 to 2022 River flow (m3/s) at 1a Ohau Poads Rd Intake N_2022_Core

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1974		?	0.651	1.467	3.073	1.584	6.635	2.175	2.834	2.856	1.19	1.562	2.411 ?
1975	0.519	0.868	2.32	2.51	5.117	2.501	4.374	4.166	3.734	2.514	1.632	3.151	2.802
1976	2.956	1.568	2.929	1.883	2.654	3.768	4.407	4.603	2.497	4.294	0.865	4.504	3.094
1977	4.034	1.047	0.814	1.284	3.367	4.3	2.841	2.808	4.571	2.203	4.499	1.571	2.783
1978	0.743	0.554	0.689	2.939	1.35	1.246	5.181	3.007	3.567	2.662	3.419	1.654	2.259
1979	2.667	2.201	1.845	3.497	4.369	2.223	3.143	2.981	2.927	4.321	2.1	3.882	3.023
1980	6.384	3.169	2.935	4.476	2.385	2.396	2.849	3.839	3.993	4.142	4.373	3.345	3.692
1981	0.818	3.666	1.665	1.033	2.939	4.94	3.835	2.042	4.038	4.473	1.062	3.107	2.795
1982	2.028	3.215	1.381	1.009	1.438	1.349	1.243	2.74	3.132	2.285	3.843	8.672	2.694
1983	1.901	1.11	4.087	3.02	3.376	2.397	2.005	3.239	4.511	4.176	6.085	2.352	3.196
1984	1.153	1.479	2.156	1.069	2.787	4.233	4.572	2.625	1.381	2.894	3.4	2.231	2.504
1985	2.599	1.083	0.964	0.559	0.932	2.724	3.804	2.46	1.755	1.395	2.641	2.868	1.99
1986	4.627	1.687	1.283	1.372	3.428	3.495	3.548	2.444	3.516	7.992	1.628	0.884	3.008
1987	2.096	1.617	1.552	2.025	2.945	2.92	1.668	2.4	2.238	3.628	1.717	3.856	2.397
1988	1.488	1.425	1.545	1.256	3.765	3.655	3.418	3.265	8.42	4.685	3.115	2.101	3.178
1989	0.806	0.464	2.266	1.644	3.36	2.56	3.109	0.738	0.679	2.36	1.661	1.532	1.766
1990	4.016	1.592	6.05	2.147	3.485	3.382	2.632	5.547	1.276	3.043	2.429	3.221	3.259
1991	4.468	5.092	1.295	4.039	1.329	2.218	3.005	5.606	2.518	3.096	3.277	6.665	3.533
1992	2.518	4.416	3.334 ?		1.244	1.506	3.134	4.643	4.141	2.743	2.602	3.496	3.086 ?
1993	2.93	1.637	0.995	2.274	5.777	4.668	1.796	2.123 ?		2.564	4.602	2.853	2.977 ?
1994	2.026	0.657	0.679	0.892	2.486	3.359	2.997	3.153	3.228	2.105	8.554	2.987	2.764
1995	2.049	1.247 ?		3.281	2.35	2.926	4.009	2.182	5.583	3.344	5.176	2.194	3.148 ?
1996	0.767	2.524	2.056	4.066	3.236	3.646	2.604	3.05	3.433	4.138	3.944	5.392	3.296
1997	0.823	2.118	4.132	2.419	0.934	0.97	1.468	2.268	1.466	6.11	4.761	5.672	2.771
1998	2.102	2.638	1.196	1.865	4.327	4.996	5.233	4.26	4.14	10.365	1.881	2.081	3.772
1999	0.974	0.632	0.683	1.157	3.596	3.055	2.685	3.24	3.015	3.226	3.292	3.144	2.403
2000	2.302	1.139	1.126	2.685	2.511	3.892	1.592	1.938	3.606	9.104	1.2	2.796	2.833
2001	2.198	1.284	1.536	0.755	1.906	1.74	2.007	4.56	1.946	3.214	4.353	4.396	2.504
2002	1.515	1.381	4.002	1.827	1.848	5.184	4.948	2.545	3.307	3.296	3.308	3.351	3.052
2003	1.037	0.482	0.31	0.329	1.458	4.092	3.082	0.852	3.001	3.45	3.237	4.992	2.203
2004	2.899	9.302	2.931	1.627	1.74	5.009	2.134	3.635	5.96	6.838	2.852	4.969	4.133
2005	5.118	0.916	1.346	0.705	2.76	2.019	2.879	1.962	1.65	2.261	0.836	3.333	2.168
2006	1.878	1.275	1.191	2.386	3.247	3.965	3.953	3.224	4.013	4.893	8.225	3.832	3.513
2007	2.246	1.562	2.529	1.12	2.589	1.694	2.722	2.612	1.546	2.959	4.459	0.595	2.225
2008	4.735	0.812	0.873	1.46	0.923	2.647	6.059	6.777	3.187	7.891	3.14	1.699	3.372
2009	1.005	4.484	0.942	0.901	2.204	0.829	1.998	2.096	1.95	3.893	5.443	6.309	2.661
2010	3.732	2.366	1.028	1.157	1.146	2.408	1.168	2.947	7.503	3.233	1.97	3.074	2.64
2011	1.252	3.743	1.303	2.794	3.306	2.591	3.622	1.462	2.348	3.699	6.439	2.533	2.911
2012	1.914	1.581	3.02	0.812	1.533	2.523	3.201	2.276	2.705	2.802	1.584	3.613	2.305
2013	2.382	1.225	0.63	1.957	1.47	2.444	2.482	1.768	4.178	4.973	1.896	1.336	2.232
2014	3.059	0.96	0.766	2.36	3.955	2.538	1.689	3.507	1.56	2.746	4.39	5.424	2.761
2015	1.01	0.962	0.93	4.152	4.959	6.121	2.112	3.94	2.941	5.039	4.526	3.42	3.35
2016	1.564	0.83	0.989	1.194	4.787	4.652	3.284	2.853	5.231	2.92	8.547	3.467	3.357
2017	7.762	6.69	2.555	4.707	3.435	1.325	3.708	4.729	5.386	3.598	1.001	0.425	3.76
2018	1.195	2.561	1.643	3.086	2.619	2.709	6.753	2.534	2.019	1.59	2.852	1.975	2.628
2019	2.471	1.777	1.48	1.399	2.131	3.751	4.609	5.683	2.268	3.994	3.999	2.175	2.989
2020	1.351	1.404	1.476	1.56	1.898	2.725	3.039	2.201	8.137	3.204	3.309	6.869	3.098
2021	1.602	0.628	1.42	1.365	2.087	5.934	3.578	4.021	3.445	2.378	3.948	7.32	3.159
2022	0.834	2.686	0.541	0.524	3.439	4.172	4.782	5.168	2.605 ?				2.754 ?
Min	0.519	0.464	0.31	0.329	0.923	0.829	1.168	0.738	0.679	1.395	0.836	0.425	1.766
Mean	2.345	2.037	1.751	1.959	2.735	3.102	3.298	3.161	3.398	3.866	3.443	3.393	2.883
Max	7.762	9.302	6.05	4.707	5.777	6.121	6.753	6.777	8.42	10.365	8.554	8.672	4.133

The Min Mean and Max of Annual values are for complete years only.
This table was produced with a gap tolerance of 360.0 hours.
There were 19 gaps in the data and 16 of these were within the gap tolerance.

Downstream Poads Rd Intake
~~~ Hilltop Hydro ~~~ Version 6.73 14-Dec-2022
~~~ PCAL ~~~

Source is E:\!Projects\P56A Poads Rd Intake Consenting\Stg3 Consenting Assessment of Effects\Results for Peer review\Data - 2takes - 7Dec22.hts
Residual flow (m3/s) at 1b Ohau Poads Rd Intake N_2022_Suppl.
From 18-Feb-1974 00:00:00 to 3-Oct-2022 24:00:00

Monthly Means 1974 to 2022 Residual flow (m3/s) at 1b Ohau Poads Rd Intake N_2022_Suppl.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1974		?	0.558	1.297	2.737	1.423	5.885	1.95	2.51	2.508	1.076	1.383	2.14 ?
1975	0.448	0.764	2.061	2.227	4.532	2.221	3.865	3.714	3.296	2.241	1.475	2.803	2.486
1976	2.616	1.404	2.618	1.663	2.361	3.346	3.88	4.056	2.229	3.827	0.772	4.016	2.747
1977	3.596	0.936	0.706	1.15	2.986	3.81	2.521	2.498	4.041	1.964	3.973	1.407	2.47
1978	0.658	0.496	0.631	2.623	1.206	1.118	4.583	2.643	3.163	2.363	3.053	1.47	2.008
1979	2.379	1.952	1.656	3.124	3.863	1.984	2.761	2.635	2.56	3.826	1.881	3.46	2.682
1980	5.669	2.837	2.626	3.974	2.114	2.121	2.526	3.408	3.507	3.669	3.866	2.971	3.275
1981	0.731	3.26	1.482	0.927	2.619	4.369	3.407	1.798	3.603	3.939	0.962	2.76	2.482
1982	1.816	2.85	1.227	0.891	1.272	1.202	1.102	2.428	2.757	2.044	3.408	7.728	2.394
1983	1.69	1	3.619	2.666	2.952	2.136	1.779	2.87	3.989	3.704	5.442	2.087	2.835
1984	1.039	1.304	1.917	0.938	2.472	3.785	4.055	2.335	1.217	2.569	3.019	2.001	2.226
1985	2.315	0.969	0.848	0.477	0.812	2.424	3.347	2.177	1.56	1.242	2.335	2.555	1.762
1986	4.116	1.498	1.15	1.207	3.04	3.1	3.138	2.171	3.122	7.106	1.452	0.777	2.671
1987	1.849	1.471	1.387	1.81	2.597	2.591	1.493	2.138	1.99	3.211	1.531	3.425	2.131
1988	1.332	1.263	1.366	1.108	3.334	3.24	3.031	2.874	7.491	4.129	2.743	1.864	2.814
1989	0.702	0.428	2.011	1.471	2.97	2.264	2.773	0.638	0.594	2.087	1.491	1.359	1.567
1990	3.586	1.432	5.407	1.919	3.082	2.962	2.287	4.924	1.138	2.719	2.156	2.812	2.89
1991	3.963	4.496	1.159	3.566	1.186	1.965	2.681	4.959	2.223	2.713	2.95	5.942	3.134
1992	2.232	3.91	2.959 ?		1.124	1.356	2.753	4.092	3.65	2.423	2.331	3.134	2.737 ?
1993	2.555	1.462	0.88	2.035	5.158	4.118	1.607	1.895 ?		2.28	4.114	2.501	2.642 ?
1994	1.814	0.57	0.579	0.775	2.21	2.963	2.647	2.751	2.823	1.856	7.621	2.684	2.444
1995	1.829	1.105 ?		2.921	2.087	2.572	3.521	1.931	4.938	2.946	4.571	1.95	2.784 ?
1996	0.68	2.248	1.831	3.582	2.842	3.194	2.27	2.669	3.037	3.661	3.504	4.817	2.914
1997	0.73	1.885	3.696	2.146	0.836	0.863	1.318	1.996	1.332	5.412	4.236	5.035	2.465
1998	1.884	2.315	1.088	1.653	3.822	4.409	4.629	3.789	3.658	9.242	1.671	1.864	3.349
1999	0.856	0.532	0.583	1.014	3.198	2.694	2.381	2.887	2.675	2.864	2.896	2.796	2.125
2000	2.053	1.021	0.999	2.391	2.215	3.462	1.424	1.735	3.217	8.147	1.066	2.5	2.527
2001	1.971	1.158	1.346	0.668	1.686	1.547	1.779	4.017	1.746	2.847	3.831	3.869	2.217
2002	1.356	1.231	3.56	1.623	1.668	4.608	4.366	2.256	2.912	2.897	2.919	2.967	2.706
2003	0.944	0.406	0.299	0.318	1.29	3.607	2.722	0.766	2.662	3.055	2.836	4.406	1.951
2004	2.533	8.285	2.609	1.453	1.547	4.456	1.882	3.218	5.293	6.067	2.491	4.385	3.663
2005	4.573	0.794	1.203	0.611	2.459	1.802	2.551	1.734	1.455	1.998	0.742	2.943	1.923
2006	1.685	1.141	1.08	2.118	2.892	3.491	3.51	2.854	3.57	4.317	7.315	3.372	3.117
2007	1.999	1.395	2.245	1.005	2.319	1.538	2.432	2.31	1.385	2.608	3.981	0.507	1.982
2008	4.24	0.705	0.75	1.29	0.811	2.357	5.366	6.012	2.824	7.021	2.799	1.524	2.995
2009	0.902	3.97	0.831	0.785	1.948	0.731	1.796	1.87	1.737	3.427	4.85	5.62	2.363
2010	3.326	2.101	0.91	1.02	1.015	2.132	1.044	2.61	6.666	2.856	1.777	2.723	2.344
2011	1.129	3.344	1.169	2.493	2.904	2.266	3.236	1.297	2.083	3.269	5.708	2.254	2.584
2012	1.713	1.409	2.683	0.716	1.363	2.224	2.875	2.018	2.399	2.469	1.417	3.202	2.048
2013	2.112	1.089	0.526	1.724	1.327	2.182	2.188	1.581	3.711	4.389	1.691	1.204	1.981
2014	2.749	0.842	0.658	2.071	3.473	2.238	1.513	3.113	1.387	2.469	3.87	4.8	2.446
2015	0.904	0.842	0.808	3.697	4.428	5.444	1.867	3.487	2.586	4.487	3.992	3.012	2.97
2016	1.415	0.73	0.871	1.059	4.235	4.115	2.887	2.53	4.644	2.565	7.611	3.059	2.974
2017	6.899	5.963	2.272	4.174	3.02	1.197	3.285	4.198	4.777	3.156	0.893	0.365	3.335
2018	1.054	2.261	1.457	2.742	2.308	2.399	6.001	2.241	1.815	1.421	2.534	1.762	2.333
2019	2.189	1.585	1.323	1.249	1.915	3.324	4.091	5.028	2.027	3.518	3.559	1.959	2.657
2020	1.202	1.261	1.306	1.409	1.693	2.428	2.685	1.946	7.237	2.817	2.897	6.105	2.749
2021	1.45	0.541	1.257	1.221	1.849	5.29	3.155	3.561	3.049	2.118	3.497	6.517	2.805
2022	0.747	2.39	0.46	0.474	3.06	3.683	4.241	4.564	2.304 ?				2.44 ?
Min	0.448	0.406	0.299	0.318	0.811	0.731	1.044	0.638	0.594	1.242	0.742	0.365	1.567
Mean	2.088	1.809	1.556	1.739	2.425	2.75	2.921	2.799	3.012	3.426	3.058	3.014	2.558
Max	6.899	8.285	5.407	4.174	5.158	5.444	6.001	6.012	7.491	9.242	7.621	7.728	3.663

The Min Mean and Max of Annual values are for complete years only.
This table was produced with a gap tolerance of 360.0 hours.
There were 19 gaps in the data and 16 of these were within the gap tolerance.

Downstream Makahika confluence
~~~ Hilltop Hydro ~~~ Version 6.73 14-Dec-2022
~~~ PCAL ~~~

Source is E:\!Projects\P56A Poads Rd Intake Consenting\Stg3 Consenting Assessment of Effects\Results for Peer review\Data - 2takes - 7Dec22.hts
Residual flow (m3/s) at 2 Ohau at d/s Makahika Confl.
From 18-Feb-1974 00:00:00 to 3-Oct-2022 24:00:00

Monthly Means 1974 to 2022 Residual flow (m3/s) at 2 Ohau at d/s Makahika Confl.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1974		?	0.935	2.13	4.466	2.321	9.603	3.178	4.105	4.116	1.754	2.269	3.5 ?
1975	0.751	1.263	3.37	3.642	7.403	3.631	6.321	6.053	5.395	3.658	2.4	4.576	4.064
1976	4.28	2.292	4.267	2.728	3.856	5.463	6.354	6.639	3.636	6.238	1.268	6.544	4.489
1977	5.861	1.534	1.175	1.88	4.879	6.224	4.12	4.08	6.607	3.208	6.498	2.298	4.037
1978	1.086	0.819	1.03	4.277	1.973	1.828	7.489	4.335	5.168	3.863	4.976	2.407	3.282
1979	3.881	3.194	2.7	5.09	6.315	3.239	4.529	4.312	4.208	6.252	3.067	5.641	4.384
1980	9.246	4.62	4.278	6.487	3.459	3.472	4.13	5.565	5.75	5.995	6.321	4.852	5.35
1981	1.202	5.32	2.425	1.517	4.273	7.14	5.561	2.952	5.872	6.451	1.568	4.508	4.056
1982	2.962	4.658	2.011	1.468	2.089	1.968	1.809	3.971	4.519	3.333	5.568	12.583	3.911
1983	2.765	1.633	5.914	4.366	4.85	3.488	2.912	4.692	6.521	6.049	8.853	3.414	4.633
1984	1.696	2.144	3.134	1.549	4.041	6.162	6.621	3.815	2.001	4.198	4.932	3.261	3.637
1985	3.78	1.587	1.4	0.802	1.346	3.958	5.484	3.565	2.553	2.035	3.823	4.169	2.887
1986	6.713	2.453	1.88	1.987	4.967	5.065	5.133	3.549	5.099	11.581	2.374	1.284	4.364
1987	3.033	2.387	2.267	2.955	4.255	4.235	2.438	3.491	3.254	5.25	2.503	5.591	3.483
1988	2.176	2.073	2.243	1.823	5.45	5.294	4.952	4.711	12.206	6.758	4.496	3.051	4.602
1989	1.165	0.701	3.289	2.403	4.86	3.707	4.522	1.063	0.987	3.418	2.432	2.227	2.566
1990	5.842	2.334	8.798	3.131	5.042	4.864	3.77	8.035	1.864	4.431	3.525	4.625	4.723
1991	6.471	7.353	1.895	5.835	1.941	3.217	4.372	8.103	3.643	4.455	4.793	9.677	5.12
1992	3.652	6.389	4.835 ?		1.832	2.211	4.517	6.698	5.976	3.968	3.797	5.099	4.474 ?
1993	4.205	2.39	1.449	3.318	8.397	6.738	2.624	3.094 ?		3.725	6.697	4.107	4.318 ?
1994	2.959	0.951	0.971	1.287	3.612	4.852	4.333	4.525	4.639	3.045	12.41	4.366	4.001
1995	2.987	1.815 ?		4.766	3.412	4.219	5.772	3.163	8.068	4.827	7.474	3.189	4.555 ?
1996	1.122	3.671	2.992	5.865	4.663	5.243	3.737	4.385	4.968	5.984	5.72	7.84	4.767
1997	1.203	3.081	6.016	3.51	1.372	1.418	2.151	3.276	2.165	8.837	6.908	8.215	4.026
1998	3.072	3.802	1.77	2.708	6.251	7.212	7.564	6.181	5.983	15.043	2.735	3.04	5.469
1999	1.414	0.898	0.978	1.673	5.219	4.412	3.894	4.71	4.372	4.678	4.747	4.566	3.481
2000	3.352	1.67	1.641	3.903	3.631	5.648	2.327	2.83	5.244	13.243	1.75	4.075	4.122
2001	3.211	1.888	2.217	1.104	2.763	2.532	2.913	6.576	2.846	4.655	6.276	6.337	3.629
2002	2.215	2.016	5.809	2.656	2.713	7.516	7.142	3.691	4.772	4.751	4.779	4.852	4.423
2003	1.537	0.689	0.485	0.515	2.118	5.905	4.457	1.255	4.351	4.995	4.657	7.207	3.194
2004	4.165	13.491	4.259	2.375	2.532	7.267	3.087	5.26	8.634	9.899	4.097	7.173	5.984
2005	7.444	1.319	1.968	1.018	4.014	2.942	4.172	2.844	2.39	3.274	1.223	4.817	3.147
2006	2.747	1.867	1.758	3.464	4.718	5.718	5.73	4.668	5.824	7.062	11.921	5.526	5.092
2007	3.266	2.28	3.671	1.644	3.778	2.498	3.965	3.782	2.262	4.274	6.484	0.853	3.238
2008	6.897	1.172	1.251	2.119	1.34	3.848	8.763	9.809	4.617	11.44	4.566	2.486	4.891
2009	1.477	6.487	1.371	1.301	3.192	1.207	2.925	3.053	2.839	5.614	7.902	9.156	3.862
2010	5.423	3.436	1.497	1.68	1.668	3.49	1.709	4.269	10.869	4.675	2.891	4.454	3.832
2011	1.842	5.447	1.91	4.066	4.763	3.726	5.272	2.127	3.407	5.347	9.317	3.682	4.223
2012	2.795	2.306	4.383	1.182	2.233	3.646	4.676	3.302	3.923	4.047	2.315	5.232	3.349
2013	3.455	1.786	0.892	2.83	2.161	3.56	3.587	2.581	6.057	7.18	2.763	1.964	3.24
2014	4.471	1.392	1.099	3.402	5.695	3.669	2.469	5.085	2.272	4.016	6.335	7.841	4.001
2015	1.482	1.393	1.341	6.029	7.21	8.875	3.059	5.701	4.242	7.314	6.533	4.935	4.854
2016	2.302	1.207	1.437	1.739	6.921	6.726	4.734	4.136	7.579	4.209	12.397	5.008	4.862
2017	11.247	9.712	3.712	6.816	4.952	1.951	5.369	6.851	7.798	5.179	1.466	0.616	5.448
2018	1.734	3.704	2.388	4.479	3.784	3.925	9.785	3.669	2.956	2.323	4.14	2.878	3.814
2019	3.582	2.591	2.163	2.043	3.118	5.432	6.678	8.214	3.307	5.761	5.805	3.186	4.34
2020	1.97	2.058	2.143	2.294	2.766	3.963	4.396	3.189	11.794	4.619	4.758	9.954	4.492
2021	2.358	0.905	2.063	1.997	3.028	8.617	5.166	5.819	4.986	3.459	5.715	10.617	4.582
2022	1.227	3.903	0.776	0.78	4.994	6.026	6.925	7.463	3.772 ?				3.991 ?
Min	0.751	0.689	0.485	0.515	1.34	1.207	1.709	1.063	0.987	2.035	1.223	0.616	2.566
Mean	3.411	2.96	2.547	2.846	3.966	4.495	4.776	4.578	4.923	5.599	4.994	4.922	4.181
Max	11.247	13.491	8.798	6.816	8.397	8.875	9.785	9.809	12.206	15.043	12.41	12.583	5.984

The Min Mean and Max of Annual values are for complete years only.
This table was produced with a gap tolerance of 360.0 hours.
There were 19 gaps in the data and 16 of these were within the gap tolerance.

Downstream Levin WTP
~~~~ Hilltop Hydro ~~~~ Version 6.73 14-Dec-2022
~~~~ PCAL ~~~~

Source is E:\!Projects\P56A Poads Rd Intake Consenting\Stg3 Consenting Assessment of Effects\Results for Peer review\Data - 2takes - 7Dec22.hts
Residual flow (m3/s) at 3 LWTP Intake N_2022_Core
From 18-Feb-1974 00:00:00 to 3-Oct-2022 24:00:00

Monthly Means 1974 to 2022 Residual flow (m3/s) at 3 LWTP Intake N_2022_Core

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1974		?	1.338	3.101	6.525	3.362	14.098	4.622	6.001	6.026	2.526	3.295	5.107 ?
1975	1.078	1.841	4.914	5.316	10.859	5.299	9.27	8.859	7.906	5.335	3.474	6.688	5.941
1976	6.259	3.322	6.228	3.973	5.629	7.997	9.325	9.744	5.301	9.132	1.817	9.581	6.562
1977	8.578	2.208	1.689	2.716	7.139	9.123	6.021	5.958	9.69	4.672	9.532	3.329	5.898
1978	1.552	1.196	1.511	6.244	2.854	2.638	10.99	6.349	7.565	5.641	7.271	3.496	4.792
1979	5.663	4.656	3.92	7.439	9.261	4.716	6.636	6.308	6.167	9.164	4.461	8.254	6.409
1980	13.57	6.744	6.243	9.505	5.048	5.068	6.035	8.148	8.438	8.785	9.269	7.097	7.833
1981	1.719	7.785	3.521	2.181	6.24	10.476	8.141	4.306	8.591	9.467	2.251	6.59	5.925
1982	4.307	6.815	2.914	2.116	3.035	2.848	2.617	5.802	6.619	4.853	8.153	18.471	5.712
1983	4.022	2.351	8.667	6.389	7.116	5.085	4.241	6.865	9.563	8.863	12.972	4.979	6.777
1984	2.442	3.113	4.566	2.238	5.905	9.015	9.705	5.567	2.903	6.135	7.214	4.744	5.307
1985	5.515	2.286	2.017	1.149	1.951	5.779	8.043	5.205	3.71	2.947	5.587	6.088	4.207
1986	9.836	3.565	2.715	2.882	7.269	7.413	7.517	5.178	7.461	17.004	3.445	1.846	6.379
1987	4.446	3.45	3.286	4.297	6.227	6.189	3.537	5.09	4.742	7.688	3.635	8.186	5.082
1988	3.151	3.005	3.257	2.639	7.983	7.752	7.247	6.901	17.921	9.92	6.583	4.446	6.732
1989	1.681	1.028	4.817	3.484	7.115	5.415	6.606	1.526	1.41	4.99	3.526	3.232	3.738
1990	8.547	3.38	12.893	4.557	7.383	7.134	5.528	11.786	2.694	6.47	5.144	6.785	6.909
1991	9.484	10.793	2.738	8.555	2.807	4.691	6.385	11.894	5.323	6.53	6.992	14.192	7.494
1992	5.331	9.367	7.073 ?		2.64	3.198	6.617	9.83	8.765	5.802	5.534	7.448	6.542 ?
1993	6.166	3.466	2.088	4.83	12.305	9.888	3.809	4.503 ?		5.436	9.802	6.016	6.311 ?
1994	4.301	1.358	1.393	1.855	5.269	7.107	6.34	6.64	6.803	4.442	18.218	6.365	5.849
1995	4.345	2.625 ?		6.967	4.977	6.177	8.471	4.613	11.844	7.071	10.971	4.647	6.666 ?
1996	1.605	5.355	4.356	8.604	6.833	7.694	5.475	6.429	7.273	8.772	8.375	11.485	6.978
1997	1.723	4.487	8.8	5.122	1.968	2.039	3.113	4.785	3.125	12.973	10.121	12.052	5.879
1998	4.467	5.563	2.546	3.941	9.167	10.586	11.101	9.051	8.772	22.089	3.979	4.42	8.006
1999	2.037	1.287	1.402	2.423	7.635	6.459	5.688	6.883	6.391	6.842	6.956	6.673	5.082
2000	4.883	2.407	2.368	5.697	5.305	8.267	3.373	4.113	7.667	19.427	2.528	5.945	6.018
2001	4.672	2.723	3.225	1.578	4.025	3.68	4.244	9.652	4.135	6.81	9.21	9.301	5.299
2002	3.209	2.917	8.503	3.863	3.935	11.019	10.483	5.389	6.991	6.963	6.999	7.101	6.468
2003	2.204	0.986	0.735	0.777	3.075	8.661	6.523	1.796	6.361	7.312	6.828	10.579	4.672
2004	6.105	19.81	6.221	3.445	3.68	10.65	4.504	7.704	12.668	14.533	6.005	10.529	8.768
2005	10.902	1.903	2.846	1.457	5.859	4.28	6.099	4.143	3.476	4.778	1.752	7.054	4.587
2006	3.989	2.696	2.53	5.053	6.896	8.387	8.391	6.83	8.526	10.365	17.503	8.104	7.452
2007	4.76	3.306	5.358	2.368	5.506	3.613	5.783	5.526	3.276	6.255	9.491	1.221	4.717
2008	10.1	1.685	1.805	3.074	1.929	5.615	12.864	14.401	6.754	16.794	6.67	3.606	7.155
2009	2.122	9.512	1.973	1.884	4.656	1.731	4.25	4.444	4.13	8.235	11.583	13.428	5.64
2010	7.933	5.011	2.157	2.433	2.41	5.094	2.465	6.242	15.958	6.843	4.195	6.514	5.595
2011	2.655	7.965	2.76	5.934	6.982	5.455	7.707	3.085	4.97	7.834	13.677	5.371	6.171
2012	4.062	3.345	6.407	1.695	3.238	5.329	6.822	4.816	5.73	5.921	3.356	7.66	4.883
2013	5.042	2.581	1.28	4.126	3.124	5.189	5.242	3.748	8.872	10.538	4.017	2.836	4.725
2014	6.52	2.007	1.581	4.974	8.357	5.363	3.581	7.441	3.296	5.851	9.295	11.508	5.847
2015	2.131	2.009	1.938	8.826	10.559	13.019	4.461	8.353	6.21	10.718	9.586	7.232	7.103
2016	3.33	1.732	2.071	2.513	10.152	9.865	6.938	6.045	11.114	6.163	18.199	7.336	7.115
2017	16.513	14.245	5.416	9.993	7.258	2.814	7.862	10.043	11.439	7.597	2.108	0.889	7.979
2018	2.515	5.413	3.469	6.547	5.532	5.735	14.36	5.36	4.294	3.368	6.048	4.187	5.569
2019	5.229	3.763	3.133	2.957	4.532	7.954	9.788	12.058	4.816	8.45	8.497	4.631	6.341
2020	2.852	2.976	3.11	3.318	4.022	5.784	6.432	4.652	17.316	6.768	6.978	14.609	6.568
2021	3.411	1.292	2.994	2.887	4.413	12.632	7.57	8.526	7.299	5.043	8.372	15.581	6.7
2022	1.755	5.697	1.107	1.141	7.319	8.837	10.152	10.954	5.511 ?				5.839 ?
Min	1.078	0.986	0.735	0.777	1.929	1.731	2.465	1.526	1.41	2.947	1.752	0.889	3.738
Mean	4.973	4.313	3.706	4.147	5.794	6.574	6.989	6.697	7.204	8.2	7.306	7.201	6.11
Max	16.513	19.81	12.893	9.993	12.305	13.019	14.36	14.401	17.921	22.089	18.218	18.471	8.768

The Min Mean and Max of Annual values are for complete years only.
This table was produced with a gap tolerance of 360.0 hours.
There were 19 gaps in the data and 16 of these were within the gap tolerance.

Appendix E

EFFECT OF CLIMATE CHANGE ON OHAU RIVER FLOW REGIME

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Damwatch Engineering Limited

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3 February 2022 WWLA0536

Poads Road WSR Hydrology Assessment

1. Introduction

Williamson Water & Land Advisory (WWLA) were commissioned by Damwatch Engineering Limited (Damwatch), through Keane Associates Limited (KAL) in December 2021 to develop a catchment flow model of the Ohau River catchment, upstream of Rongomatane (**Figure 1**). The purpose of the model was to simulate the historical flow record and nine climate change scenarios, which will be used to support the feasibility assessment currently being undertaken by Damwatch for an off-river raw water storage reservoir on Poads Road, for Horowhenua District Council.

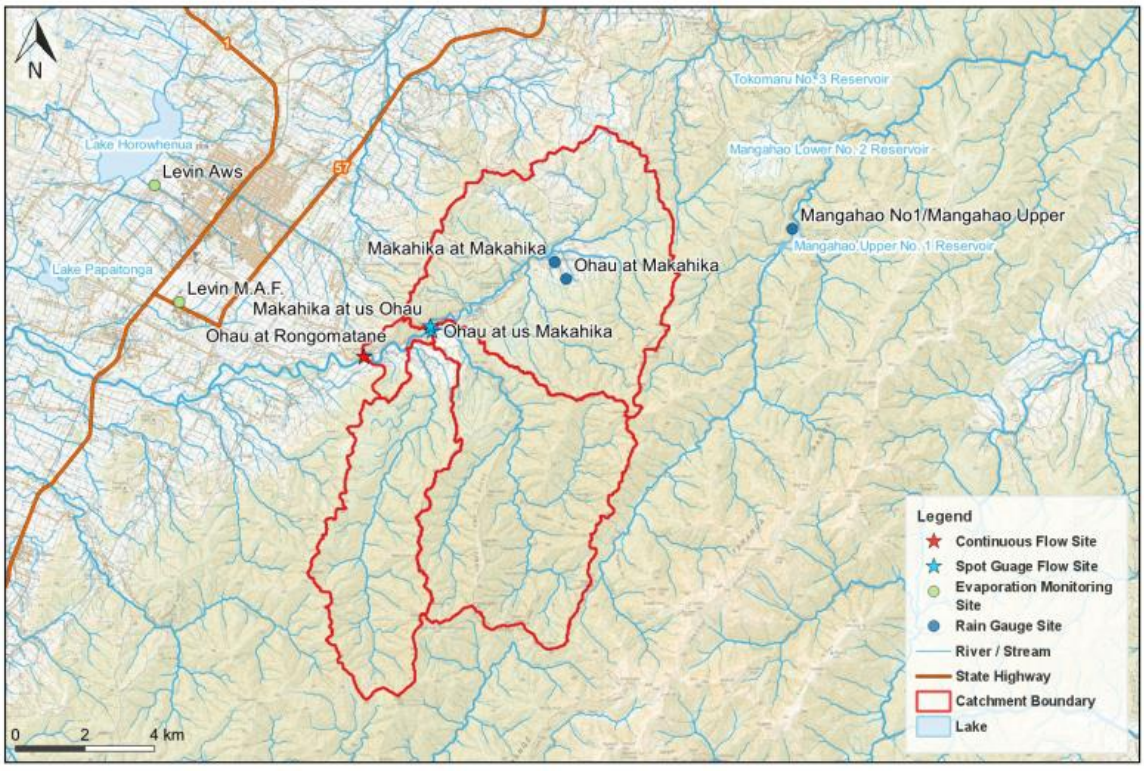


Figure 1. Property overview map.

Simulated flows were required for the following locations, and are displayed on **Figure 1**:

- Ohau River at Rongomatane;
- Ohau River at upstream of Makahika confluence; and
- Makahika Stream upstream of Ohau confluence.

Simulated flows representative of the following scenarios were required:

- Historical climate;
- Climate change adjusted RCP 2.6 for 2050;
- Climate change adjusted RCP 2.6 for 2100;
- Climate change adjusted RCP 4.5 for 2050;
- Climate change adjusted RCP 4.5 for 2100;
- Climate change adjusted RCP 6.0 for 2050;
- Climate change adjusted RCP 6.0 for 2100;
- Climate change adjusted RCP 8.5 for 2050; and
- Climate change adjusted RCP 8.5 for 2100.

This letter details the development and calibration of the catchment flow model, development of the climate change scenarios, and presents summary outputs for all scenarios. Full time series outputs for all scenarios are provided in the Excel file titled "WWLA - *Ohau River Catchment Modelling Outputs 03022021.xlsx"* provided alongside this letter.

2. Hydrological Model Development

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. A conceptual schematic of the SMWBM is provided in **Appendix A**.

2.1 Available Measured Flow Data

Continuous and spot gauge measured flow data were available from seven locations within the Ohau River catchment and are summarised in **Table 1**. These datasets were used to calibrate the catchment flow model (**Section 2.4**).

Table 1. Summary of available measured flow data.

Name	Type	Period (Number of data points)
Ohau River at Rongomatane	Continuous	24/08/1978 to 07/10/2021 (15,732)
Ohau River at Rongomatane (Naturalised)	Continuous	18/02/1974 to 15/04/2003 (10,498)
Ohau River upstream of Makahika Confluence	Spot Gauge	27/02/1989 to 08/06/2021 (22)
Makahika Stream above Ohau Confluence	Spot Gauge	27/02/1989 to 06/08/2019 (51)
Ohau River at Water Race	Spot Gauge	23/01/1974 to 27/03/2003 (118)
Waiti Stream at Gladstone Bridge	Spot Gauge	15/03/1974 to 27/03/2003 (14)
Makahika Stream at Makahika Station Ford	Spot Gauge	15/03/1974 to 27/04/1976 (10)

The Ohau River at Rongomatane (Naturalised) flow dataset was developed and provided by HDC. No information was provided describing the naturalised dataset. The naturalised dataset has higher flows than the raw measured dataset, which are particularly noticeable during low

flows. This is as expected given the effect of upstream water abstractions has been removed (i.e., a naturalised streamflow).

2.2 Rainfall

A desktop review of all available rainfall datasets was undertaken. A strong annual rainfall gradient exists across the Ohau River catchment and wider Tararua Ranges, increasing towards the catchment headwaters to the east.

The catchment flow model was initially configured using measured rain gauge data from the Ohau at Makahika and Makahika at Makahika rain gauges, located near the middle of the Makahika River catchment (**Figure 1**). Initial calibration simulations revealed the simulated flow was constantly under-simulated in comparison to both the measured and naturalised flow series for the Ohau River at Rongomatane. From a water balance perspective, this suggests both Makahika rain gauges underestimate average rainfall across the entire catchment – due to higher rainfall in the catchment headwaters.

A second preliminary flow model was configured using rainfall from the Mangahao Upper and Mangahao No. 1 Dam rain gauges (**Figure 1**). The Mangahao Upper rain gauge operated from May 1925 to December 1977, and was then renamed the Mangahao No.1 dam rain gauge, and has operated until present. Preliminary simulated flow outputs showed a significantly improved match to both the measured and naturalised flow series for the Ohau River at Rongomatane. Rainfall from the Mangahao Upper / No. 1 Dam rain gauges gave a significantly more accurate water balance and was therefore considered representative of rainfall across the entire Ohau River catchment, and hence was used in the modelling.

The average annual rainfall for the Mangahao Upper / No.1 Dam record is 3,078 mm, and annual average rainfall is presented in **Figure 2**.

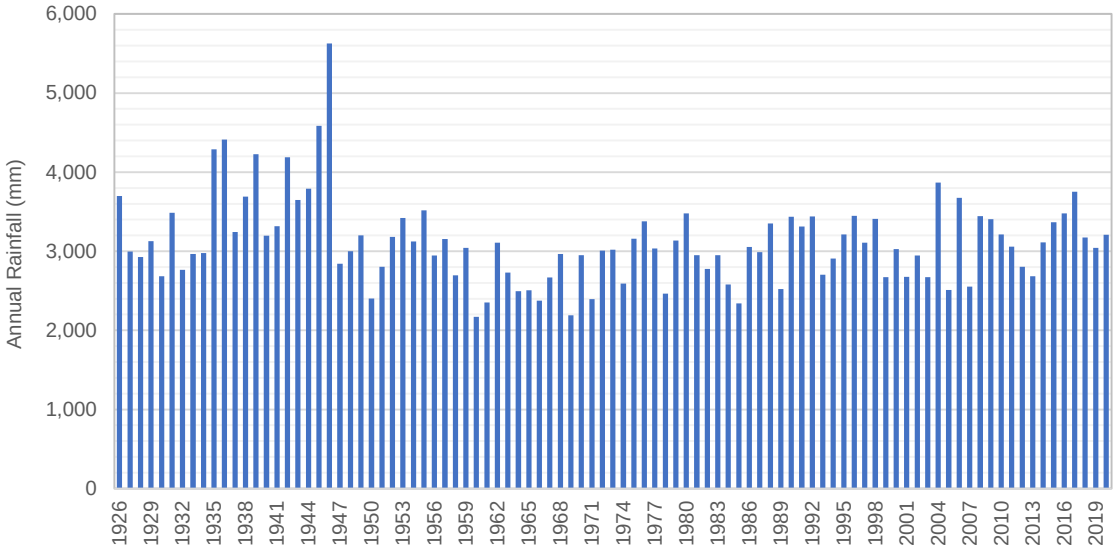


Figure 2. Annual rainfall at Mangahao at No.1 Dam / Upper.

2.3 Evaporation

Available evaporation monitoring sites were more limited in comparison to rainfall, with only two sites available in relatively close proximity to the study area; the Levin M.A.F site, and the Levin

AWS station. The Levin M.A.F station covered the period from January 1968 to November 1990. The Levin AWS station covered the period from November 1991 to the present.

In order to infill the gap in data between the two sites and to extend the record to cover the same period as the rainfall data, average monthly evaporation was calculated from the two available datasets, and uniform monthly values assigned to infill and extend the time series.

The annual evaporation record from the combined and infilled dataset is presented in **Figure 3**.

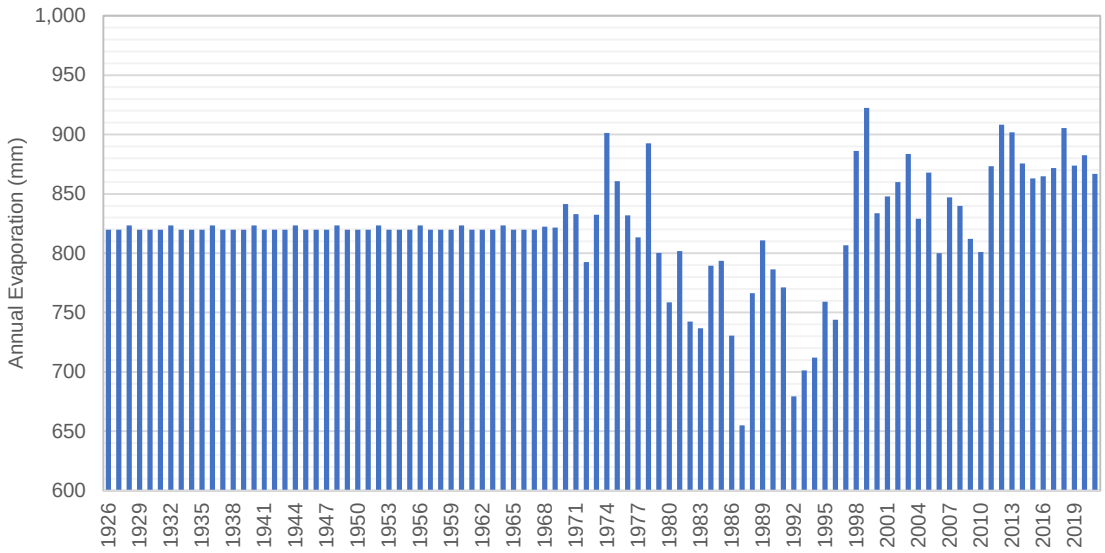


Figure 3. Annual recorded evaporation combined from Levin M.A.F and Levin AWS.

2.4 Model Calibration

The Ohau River catchment flow model was calibrated by comparing simulated flow to the continuous flow datasets (**Section 2.1**), and to spot gauge data as a secondary check. Model parameters were adjusted to obtain the best fit between simulated and measured flow. A comparison of the simulated streamflow and both the measured flow and naturalised flow hydrographs for Oahu River at Rongomatane is presented in **Figure 4**, and a zoomed in snapshot in **Figure 5**. A comparison of the flow duration curves is presented in **Figure 6**.

Based on visual observation of the hydrographs and flow duration curve, the simulated flow shows good agreement to both the measured flow sets, with improved match to the naturalised flow dataset during periods of low flow (i.e. when abstractions are occurring in the measured flow dataset). Good agreement is particularly observed during periods of summer low flows (i.e., the area of focus in regards to the proposed Poads Rd WSR abstraction).

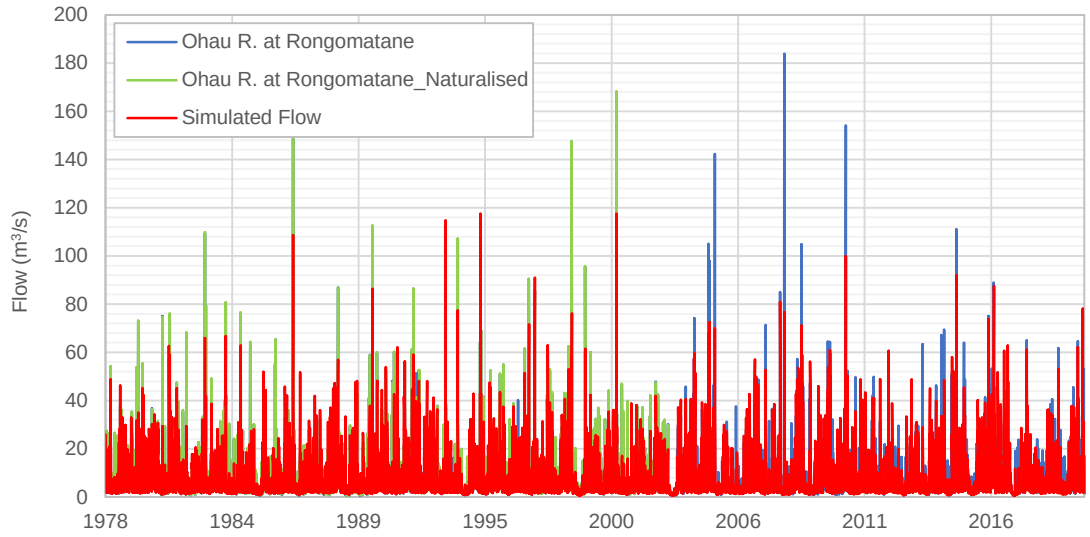


Figure 4. Comparison of measured and simulated flow hydrographs.

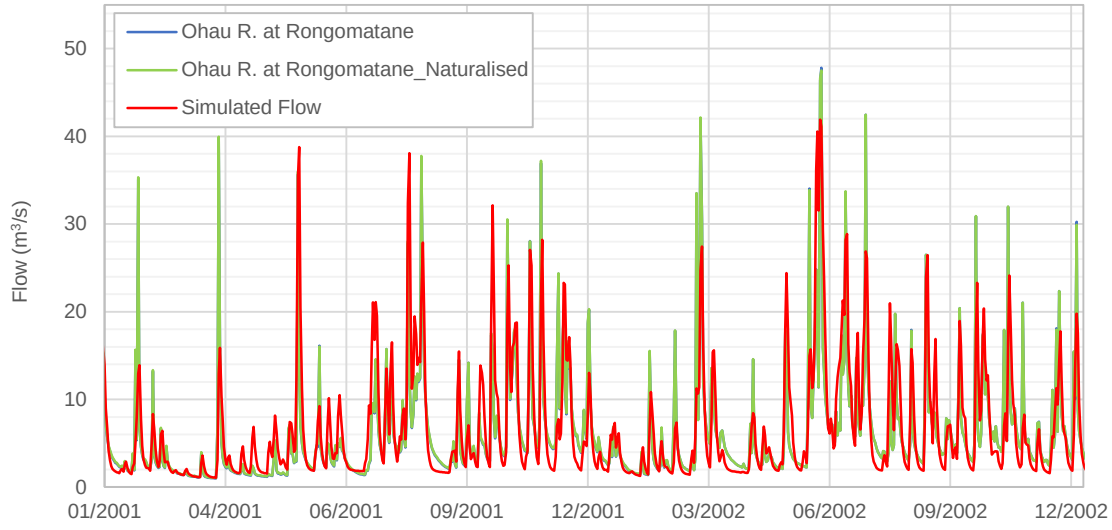


Figure 5. Comparison of measured and simulated flow hydrographs between 2000–2002.

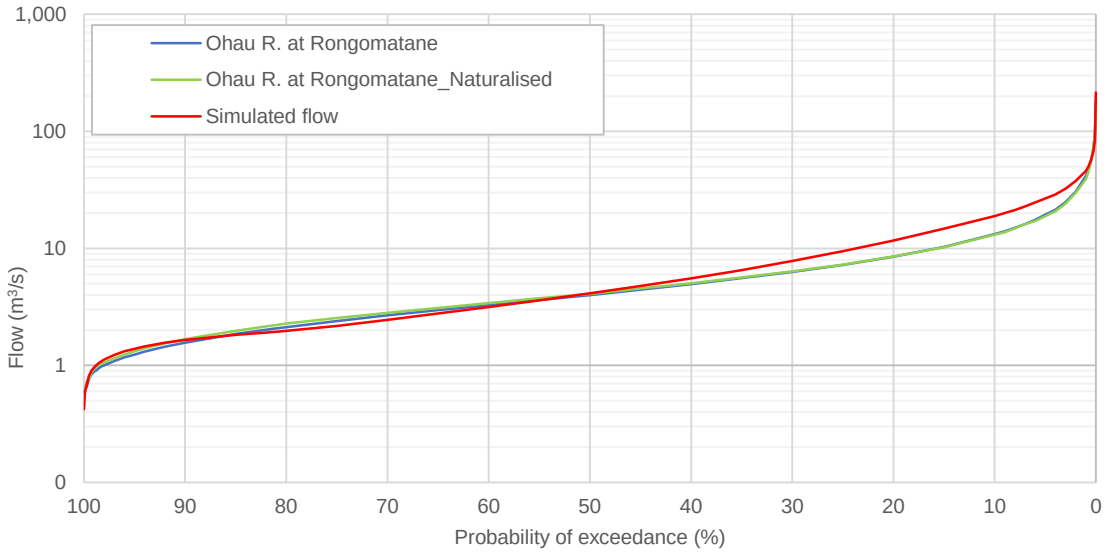


Figure 6. Comparison of measured and modelled flow duration curves.

A comparison of simulated flow to spot gauge flow measurements is presented in **Appendix B**, which also show good agreement between the simulated and measured flows.

3. Simulated Historic Streamflow Record

The catchment model was used to simulate the historic streamflow record, covering the period January 1926 to December 2020 at the three assessment locations.

The simulated flow hydrographs and flow duration curves for the three assessment locations are presented in **Figure 7** and **Figure 8**, respectively.

Summary flow statistics for the three sites are presented **Table 2**.

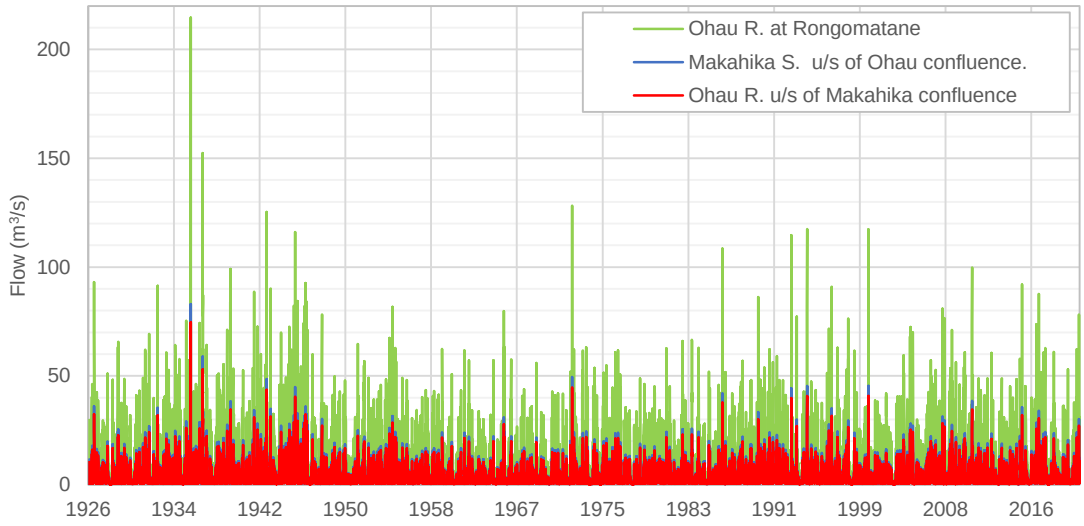


Figure 7. Simulated flow hydrograph for three proposed locations.

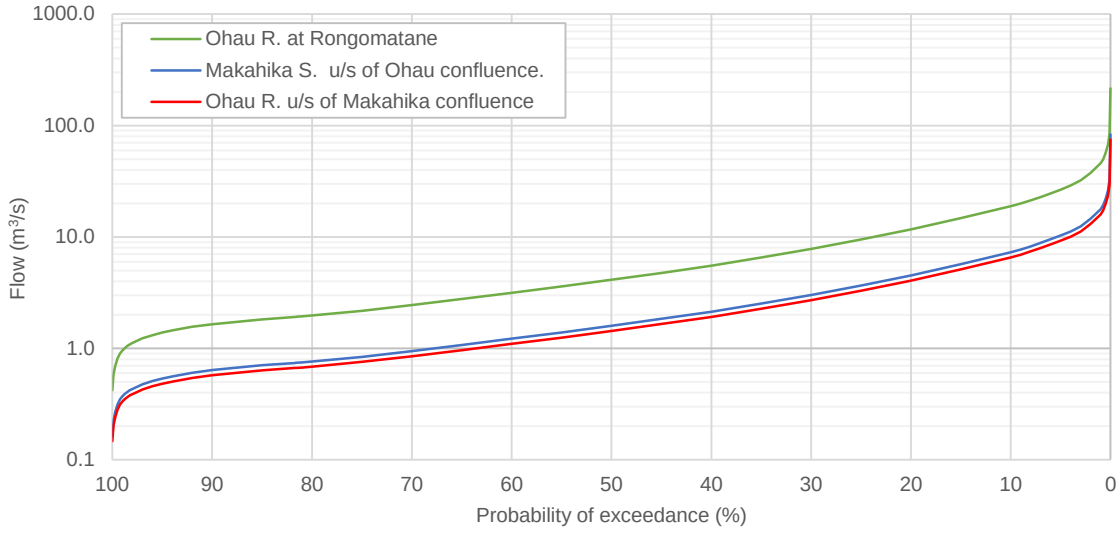


Figure 8. Comparison of flow duration curves at the three assessment locations.

Table 2. Simulated summary flow statistics – historic record 1926–2020.

Statistic	Oahu River at Rongomatane	Ohau River u/s Makahika confluence	Makahika Stream u/s Ohau confluence
Catchment Area (ha)	10,500	3,650	4,060
Minimum (m^3/s)	0.42	0.15	0.16
25th Percentile (m^3/s)	2.18	0.76	0.84
Median (m^3/s)	4.13	1.44	1.60
Mean (m^3/s)	7.83	2.72	3.03
75th Percentile (m^3/s)	9.48	3.30	3.67
95th Percentile (m^3/s)	26.63	9.26	10.30
Maximum (m^3/s)	214.61	74.60	82.98

4. Climate Change Scenarios

4.1 Scenario Development

In order to develop model input rainfall and evaporation time series representative of the eight climate change scenarios, a seasonal percentage adjustment was applied to the historical rainfall and evaporation time series. It should be noted, this approach takes into account the estimated change in total depth of rainfall, but does not capture potential changes in the temporal variability in rainfall associated with climate change.

Estimates of seasonal percentage change in rainfall for the Horizons region are published in NIWA (2016[1]) and summarised in **Table 3**. These seasonal adjustments were applied directly to the historic rainfall record to develop eight climate change adjusted rainfall datasets.

[1] NIWA, 2016. Climate Change and Variability - Horizons Region. Horizons Report 2016/EXT/1499

Table 3. Rainfall percentage adjustment factors for climate change scenarios.

Season	2030–2050				2081–2100			
	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
Summer	0%	0%	-1%	0%	3%	2%	0%	0%
Autumn	1%	1%	1%	0%	3%	1%	1%	-2%
Winter	4%	6%	6%	7%	6%	9%	11%	14%
Spring	1%	1%	0%	1%	3%	1%	2%	1%

NIWA (2016) did not report on estimates of seasonal percentage change in evaporation, and no comparable analysis was identified during a high-level literature review. Therefore, it was agreed with KAL that the seasonal percentage change in temperature would be used as a proxy for changes in evaporation on the basis that both temperature and evaporation are partially interdependent. For example, warmer temperatures will typically result in increased evaporation.

The seasonal percentage change, applied as a proxy for percentage change in evaporation, for the eight climate change scenarios are summarised in **Table 4**.

Table 4. Evaporation percentage adjustment for climate change scenarios.

Season	2030–2050				2081–2100			
	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
Summer	0.7%	0.9%	0.9%	1.1%	0.7%	1.5%	1.9%	3.3%
Autumn	0.8%	0.9%	0.9%	1.1%	0.7%	1.5%	1.9%	3.2%
Winter	0.7%	0.9%	0.8%	1.1%	0.7%	1.5%	1.9%	3.2%
Spring	0.6%	0.8%	0.7%	0.9%	0.6%	1.3%	1.6%	2.7%

4.2 Simulated Climate Change Scenarios

Eight climate change catchment flow models were developed by replacing the historic rainfall and evaporation model input files with the climate change adjusted files. All other model parameters remained the same as determined for the calibrated historical basecase scenario.

Simulated summary flow statistics for the three assessment locations, and nine climate scenarios are presented in**. Table 5, Table 6,** and, **Table 7**. Flow hydrographs and flow duration curves are not presented for the sake of simplicity, but the full simulated daily flow records are provided in the spreadsheet supplied alongside this letter.

Table 5. Climate change scenario summary statistics for the Oahu River at Rongomatane.

Statistic	Historic	2030–2050				2081–2100			
		RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
Minimum (m^3/s)	0.423	0.417	0.415	0.411	0.413	0.429	0.412	0.408	0.383
25th Percentile (m^3/s)	2.175	2.185	2.187	2.178	2.182	2.219	2.194	2.195	2.152

Statistic	Historic	2030–2050				2081–2100			
		RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
Median (m^3/s)	4.132	4.187	4.204	4.174	4.193	4.296	4.241	4.254	4.151
Mean (m^3/s)	7.834	7.981	8.032	7.982	8.033	8.206	8.124	8.171	8.005
75th Percentile (m^3/s)	9.480	9.652	9.718	9.637	9.712	9.991	9.821	9.871	9.602
95th Percentile (m^3/s)	26.628	27.240	27.521	27.336	27.504	28.117	27.920	28.122	27.655
Maximum (m^3/s)	214.61	216.77	216.76	214.58	216.76	221.14	216.74	216.73	210.17

Table 6. Climate change scenario summary statistics for the Ohau River upstream of Makahika stream confluence.

Statistic	Historic	2030–2050				2081–2100			
		RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
Minimum (m^3/s)	0.147	0.145	0.144	0.143	0.144	0.149	0.143	0.142	0.133
25th Percentile (m^3/s)	0.756	0.760	0.760	0.757	0.758	0.771	0.763	0.763	0.748
Median (m^3/s)	1.436	1.456	1.461	1.451	1.457	1.493	1.474	1.479	1.443
Mean (m^3/s)	2.723	2.774	2.792	2.775	2.792	2.853	2.824	2.840	2.783
75th Percentile (m^3/s)	3.296	3.355	3.378	3.350	3.376	3.473	3.414	3.431	3.338
95th Percentile (m^3/s)	9.257	9.469	9.567	9.502	9.561	9.774	9.706	9.776	9.613
Maximum (m^3/s)	74.60	75.35	75.35	74.59	75.35	76.87	75.34	75.34	73.06

Table 7. Climate change scenario summary statistics for the Makahika Stream upstream of Ohau river confluence.

Statistic	Historic	2030–2050				2081–2100			
		RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
Minimum (m^3/s)	0.163	0.161	0.160	0.159	0.160	0.166	0.159	0.158	0.148
25th Percentile (m^3/s)	0.841	0.845	0.846	0.842	0.844	0.858	0.848	0.849	0.832
Median (m^3/s)	1.598	1.619	1.625	1.614	1.621	1.661	1.640	1.645	1.605
Mean (m^3/s)	3.029	3.086	3.106	3.086	3.106	3.173	3.141	3.159	3.095
75th Percentile (m^3/s)	3.666	3.732	3.758	3.726	3.755	3.863	3.798	3.817	3.713
95th Percentile (m^3/s)	10.296	10.533	10.642	10.570	10.635	10.872	10.796	10.874	10.693
Maximum (m^3/s)	82.98	83.82	83.81	82.97	83.81	85.51	83.81	83.80	81.27

5. Closure

The historical streamflow record plus eight climate change scenarios were simulated using a calibrated catchment flow model. The climate change scenarios are considered representative of the seasonal change in rainfall between scenarios, but do not take into account potential changes in temporal variation in rainfall (i.e., longer drought periods or more frequent storm events).

Simulated daily streamflow representing nine climate scenarios (historic + eight climate change scenarios) are provided in the attached Excel spreadsheet, separately for each of the three requested assessment locations.

Yours sincerely,

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Appendix A: Soil Moisture Water Balance Model Description

The Soil Moisture Water Balance Model (SMWBM) is a semi-deterministic model based on the algorithms of Pitman (1967), who originally developed the model to simulate river flows in South Africa. Model functionality has been extended by WWLA recently to incorporate a surface ponding function, evaporation functions for differing land cover, vadose zone unsaturated flow and travel time, and an irrigation demand module.

The model can operate using either daily or hourly rainfall and daily evaporation input data to calculate the soil moisture conditions under natural rainfall conditions. The model operates on a daily time step during dry days, however when rain days occur, a finer hourly calculation step is implemented to enable peak flows to be assessed more accurately than a daily time step model.

As outlined in **Table 8,** the SMWBM version utilised in this project incorporates parameters characterising the catchment in relation to:

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

Table 8. SMWBM parameter description.

Parameter	Name	Description
ST (mm)	Maximum soil water content	ST defines the size of the soil moisture store in terms of a depth of water.
SL (mm)	Soil moisture content where drainage ceases.	Soil moisture storage capacity below which sub-soil drainage ceases due to soil moisture retention.
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.
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.
ZMIN (mm/hr)	Minimum infiltration rate	
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.
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.
AI (-)	Impervious portion of catchment	AI represents the proportion of the catchment that is impervious and directly linked to surface water drainage pathways.
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.
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.
TL (days)	Routing coefficient for surface runoff	TL defines the attenuation and time delay of surface water runoff.
GL (days)	Groundwater recession parameter	GL governs the attenuation in groundwater discharge or baseflow from a catchment.
QOBS (m^3/s)	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.
AA, BB	Coefficients for rainfall disaggregation.	Used to determine the rainfall event duration and pattern.

A conceptual diagram of the key components of the SMWBM model structure and functionality is shown in **Figure 9**.

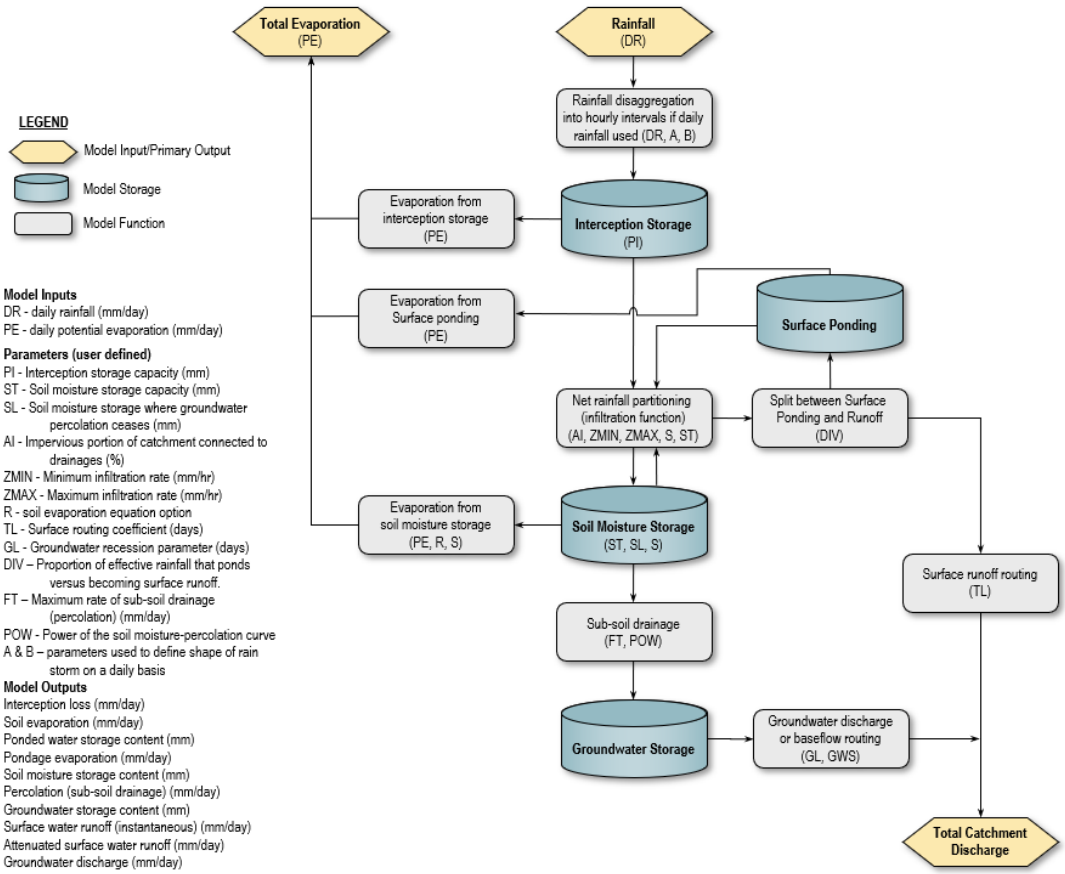


Figure 9. Schematic of the SMWBM structure and parameters.

Appendix B: Spot Flow Locations

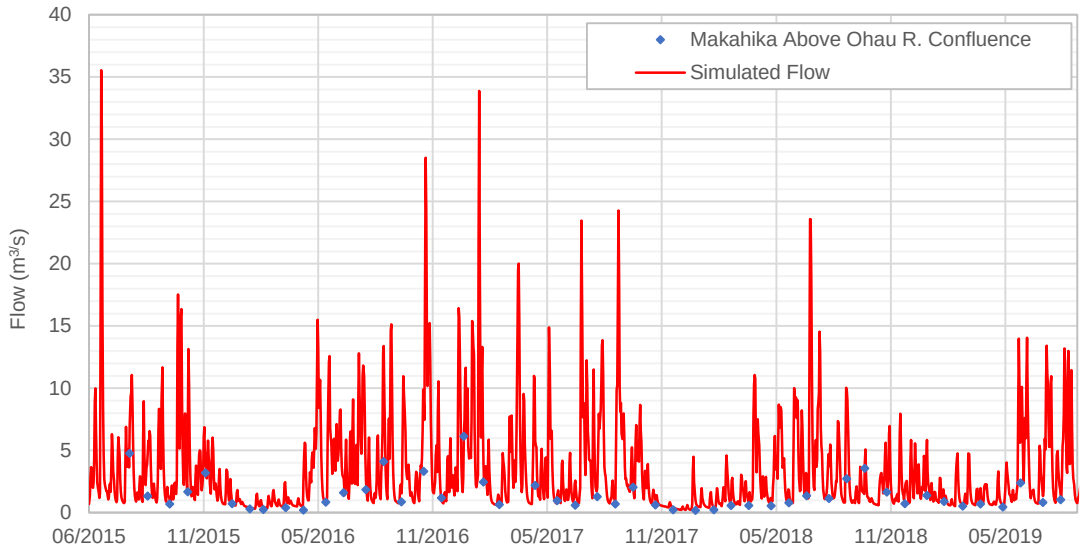


Figure 10. Hydrograph of simulated flow and spot gauge recordings from Makahika above Ohau River Confluence.

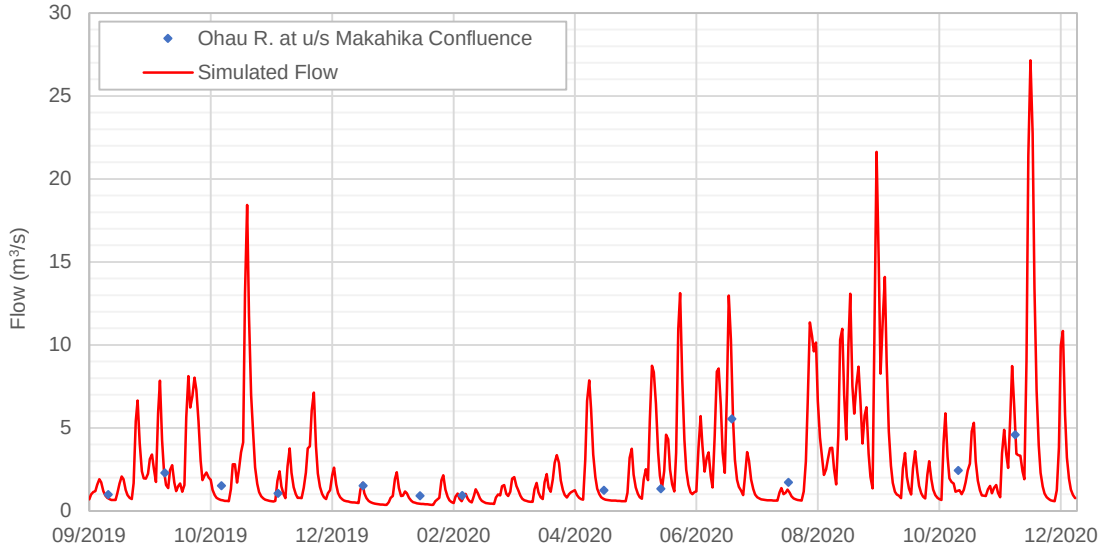


Figure 11. Hydrograph of simulated flow and spot gauge recordings from Ohau River upstream of Makahika Confluence.

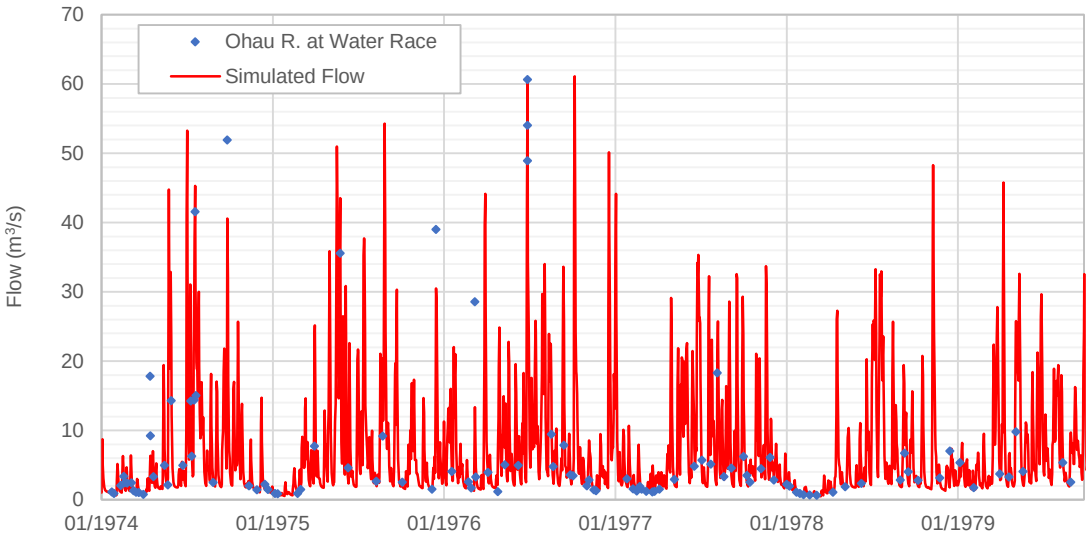


Figure 12. Hydrograph of simulated flow and spot gauge recordings from Ohau River at Water Race.

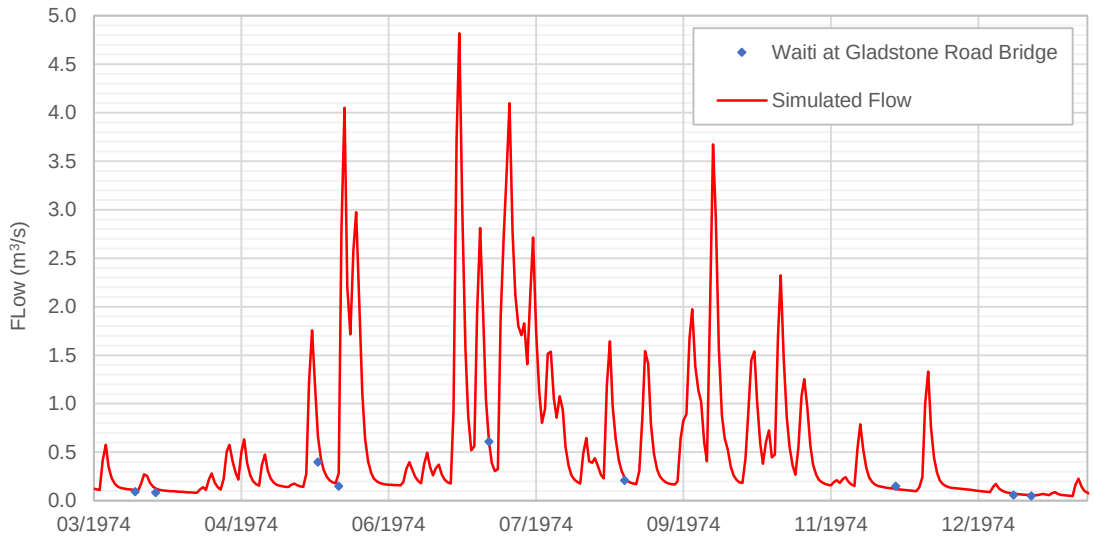


Figure 13. Hydrograph of simulated flow and spot gauge recordings from Waiti at Gladstone Road Bridge.

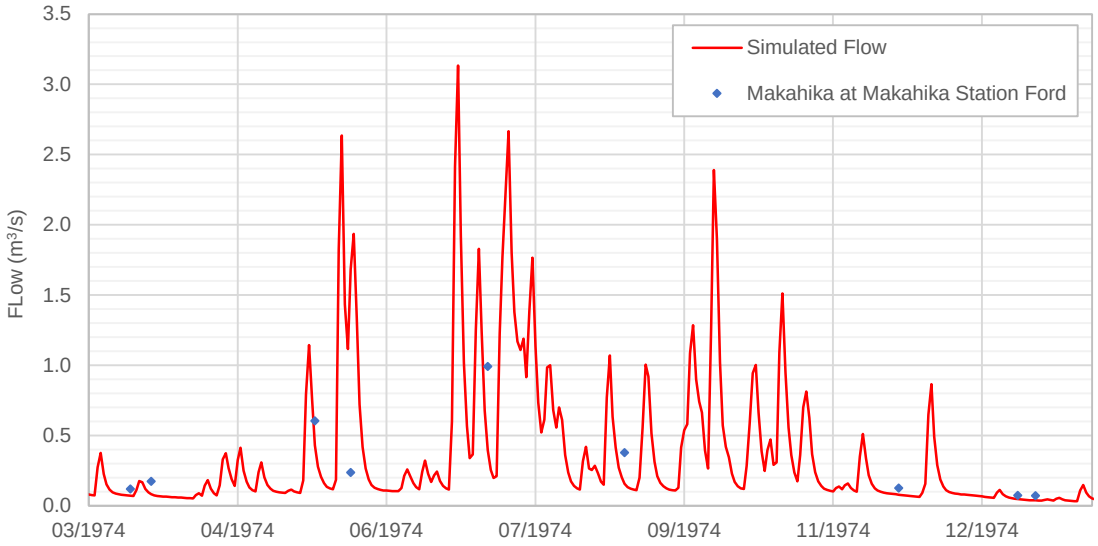


Figure 14. Hydrograph of simulated flow and spot gauge recordings from Makahika at Makahika at Station Ford.

Appendix F

CULTURAL IMPACT ASSESSMENT

Assessment of effects on Muaūpoko values

Proposed Taitoko Drinking Water Scheme

FOR HOROWHENUA DISTRICT COUNCIL

MARCH 2023



www.muaupoko.iwi.nz

Taitoko | Levin

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Executive summary

Horowhenua District Council (HDC) are proposing to construct a new water reservoir adjacent to the Ohau River to supply Taitoko (Levin) and the surrounding communities with a resilient drinking water connection. The reservoir will be located near Poads Road. HDC have adopted a staged approach to consenting the reservoir. This cultural impact assessment (CIA) assesses the effects of the following stages which we are confident are minimising effects on the mauri of the Ohau Awa to the greatest practicable degree while providing certainty for our community to meet their health needs:

- Increase the existing water take from the Ohau River for municipal consumption by 409m^3/day, resulting in a total take of 15,409m^3/day which will be reconsented.
- Minimising take from the Ohau Awa when the awa is in low flow.
- Harvesting 10% of the flow when the awa is above median flow.
- Works within the bed and riparian margin of the Ohau Awa to construct a new intake structure and a pipe bridge that will convey water from the reservoir, over the Ohau Awa, to the water treatment plant.

Resource consent for the actual construction of the reservoir and a Notice of Requirement to designate the site will be lodged at a later date.

This CIA has been prepared to ensure the values of Muaūpoko are addressed when the effects of the new water take and preliminary construction activities are assessed, as is required under the Resource Management Act 1991. In this document, we describe how Muaūpoko have participated in the project to date and the values we hold with the environment. We identify and assess the magnitude of residual effects the proposed activities will have on our values and recommend actions to manage any adverse effects to an acceptable level and meet our aspirations.

The proposed quantum of water taken from the Ohau Awa, especially at low flow will affect the mauri of the awa, other waterbodies and groundwater that are hydraulically connected to it. The impact on mauri will have adverse effects on Muaūpoko values which must be managed, positive actions must be undertaken to enhance the mauri of the Ohau Awa to offset for the effects the water take will have. The necessity of the project is recognised and Muaūpoko is supportive of a more resilient water supply for Taitoko and the surrounding communities. Our concerns around Horizons Regional Council allocation framework in the Ohau catchment will not be alleviated through this project. However, holding an active role in the continual improvement of the environment will ensure our values, such as mana whakahaere and manaakitanga, can be

provided for in a positive way that uplifts our mātauranga and our people. We are looking to create pathways and provide opportunities for decision-making and mahi for our people, whether that be in the planning, construction, kaitiakitanga or kaupapa taiao spaces.

Authentic Muaūpoko engagement is limited by our capacity constraints in relation to the broader Te Tiriti relationship with HDC. To mitigate these adverse effects, it is proposed Muaūpoko are supported in their role as kaitiaki of the Ohau Awa and the surrounding environment to build capacity and capability. This would ensure the project, and HDC, are giving effect to the principle of mana whakahaere, pursuant to Te Mana o te Wai provisions in the National Policy Statement for Freshwater Management. For example, HDC have proposed a condition (Condition 6 in the draft AEE) which would establish a mana whenua group with representatives from Muaūpoko and Ngāti Raukawa to advise on the future management of the Ohau Awa. Muaūpoko supports this proposal as a way to recognise the role of Muaūpoko as kaitiaki. We make comments on the structure and role of the group in this CIA and more broader recommendations on our involvement as kaitiaki going forward.

We acknowledge the partnership we are creating with HDC and the journey ahead to fulfilling our agreement as Te Tiriti partners.

1 Introduction

HDC has identified the need to augment their current water supply and storage facilities for the Taitoko Water Treatment Plant. The current consent (ATH-1991006011.03) authorises the abstraction of up to 15,000 m^3/day of water from the Ohau Awa to meet the public water supply needs of Taitoko including 13,000 m^3/day during low flows. This take was authorised until 2042, however growth within Taitoko has been significantly higher than projected. Despite extensive works to improve the network and pressure controls, we understand the existing water allocation will be insufficient to meet the needs of our community.

HDC proposes to construct a new water reservoir adjacent to the Ohau Awa to increase water supply capacity, minimise their effects on the awa at sensitive times of low flow and improve the resilience of the Taitoko drinking water supply. HDC are taking a staged approach to consenting as the reservoir design progresses. This cultural impact assessment (CIA) has been prepared to inform the following consents:

- Water take for reservoir storage, being 15,409m^3/day consumptive and 750m^3/day non-consumptive for flushing of the pipe network
- Redundancy in the reservoir to protect the awa when it is below minimum flow
- Water harvesting of 10% of the flow in times the Ohau Awa is above median flow level
- Construction of a new inlet in the Ohau Awa
- Construction of a new pipe bridge across the Ohau Awa to connect the reservoir with the drinking water plant

Further consent will be sought for the reservoir construction activities once detailed design is at a sufficient stage. A Notice of Requirement is being applied for separately, and has not been assessed at the time of writing this CIA.

The purpose of this (CIA) is to inform resource consent for the proposed Taitoko drinking water scheme, excluding the construction and designation of the reservoir. In this document, we (Muaūpoko Tribal Authority Inc (MTA)) describe the values Muaūpoko hold with the environment, identify and assess the magnitude of effects the scheme project has on these values, and recommend actions to manage any adverse effects to an acceptable level.

1.1 Assessment context

Our assessment has been developed with reference to:

1. Assessment of effects on the environment (draft), prepared by Good Earth Matters, 2023 and associated appendices

2. Levin Water Supply: Water Supply Augmentation Operational Framework November 2022

3. Site visits alongside HDC representatives

1.2 Project scope

The project will involve the construction of a new water reservoir at Lots 9, 10, and 11 adjacent to Poads Road, on a river terrace approximately 6km southeast of Taitoko (see Appendix A). The reservoir will receive water from the Ohau Awa via a new intake structure. The existing consented rate of water extraction from Ohau Awa is 15,000m^3/s for consumption and 750m^3/day for non-consumptive purposes, which must be returned to the river within 400m of the abstraction point. The additional water (409m^3/day and water harvesting above median flow) will be taken from Ohau Awa to fill the proposed large water storage reservoir to meet the demand of the expected population growth in Taitoko.

The current low flow take of 13,000m^3/day uses around 18% of the flow in low flow conditions (which is set at 820l a second). This is having a significant impact on the mauri of the awa and degrades the habitat for our taonga species. Through adaptive management and use of the reservoir a theoretical reduction in take below low flow to 7500m^3/day would reduce this to around 10.5% of flow extraction when the awa is in low flow. This is a significant reduction or minimisation of effects however residual effects on mauri and habitat availability still exist.

Works will be required within the bed of the Ohau Awa for the construction of an inlet structure (infiltration gallery) and a pipe bridge to convey water from the reservoir to the water treatment plant. Discharge permits are sought to provide for overtopping/pumping down a spillway, maintenance drawdown and to discharge groundwater from below the reservoir to land. The Ohau Awa will be the receiving waterbody for any discharges to land. Groundwater will be diverted from below the reservoir for construction and structural purposes.

1.3 Project context

The Taitoko drinking water supply is currently sourced directly from a subsurface intake on the Ohau Awa approximately 5km south-east of the Taitoko town centre. As there is a single reticulation network, all water is treated to meet the New Zealand Drinking Water Standards, regardless of the end use. The existing intake is aging and the bed of the awa at the point of

abstraction requires regular scarification to ensure unobstructed flows into the inlet. High turbidity events in the Ohau Awa overwhelm the existing treatment plant, as sediment laden water freely enters the inlet. This further reduces the capacity of the treatment plant to supply the population of Taitoko. The residents of Taitoko are consistently asked to reduce their water use in response to rainfall events and associated sedimentation of the awa overwhelming the treatment plant. This is not good for the health and wellbeing of our community.

There is currently 12,000m^3 of post-treatment storage at the current water treatment plant, comprising of one 6,000m^3 stainless steel tank and two smaller concrete tanks. This volume is estimated to provide 1.25 days storage for Taitoko at the current average demand – potentially reducing in the event of an earthquake because the older concrete tanks do not meet seismic standards. This is not a resilient water supply for disruptions that extend beyond one day and highlights the need for a new water supply system for our community. Currently some communities in Ohau and Waitārere are self-serviced for drinking water. The additional allocation from the Ohau Awa would allow these communities to connect to the Taitoko reticulated system for a more resilient supply of water.

The Ohau Awa is largely hill-fed with multiple springs contributing to the flow along the length of the awa. The river is terraced in the vicinity of the proposed reservoir site, with floodplains below the terraces. The proposed site is currently used for grazing and is predominantly exotic grassland. The northern terrace within the project area is in a Horowhenua District Council flood hazard area. Freshwater springs exist along those terraces, feeding wetlands within and below the reservoir site[1]. Further delineation is required at the time of writing this assessment to determine whether the wetlands can be classified as ‘natural wetlands’ under the NPS-FM. One spring is a significant feeder for a wetland below the reservoir site[2] and an area of permanent soil exists in the reservoir site.

In the upper catchment, the Ohau Awa has high water quality and macroinvertebrate metrics indicating high instream habitat values. Near the coast, higher *E. coli* concentrations, reduced water clarity and invertebrate metrics all indicate an overall decline in ecological health as it flows across the plains. Both the upper and lower Ohau sub-zones provide important habitat for redfin bully, bluegill bully, torrent fish, our taonga tuna, banded kokopu, pīrau (lamprey) among other high values aquatic taonga.

[1] Wildland Consultants 2022

[2] Springs were identified during a site visit in late 2022.

1.4 Muaūpoko organisations

Our assessment has been approved by the MTA Board of Trustees, representatives of our Muaūpoko hapū.

1.4.1 Muaūpoko Tribal Authority

The MTA is the mandated organisation for the Muaūpoko Iwi. The MTA represents Muaūpoko for the purposes of the Resource Management Act 1991 (RMA) and is mandated by the Crown for Treaty of Waitangi settlement negotiations and under the Māori Fisheries Act 2004. It is also an Iwi Aquaculture Organisation under the Māori Commercial Aquaculture Claims Settlement Act 2004.

The Muaūpoko statutory area, for the purposes of Treaty settlement processes for the Manawatū ki Porirua District Enquiry, shows the area from the main stem of the Manawatū River down to Porirua Harbour. However, the traditional Muaūpoko area of interest for RMA purposes stretches from the Rangitikei River to Turakirae (Cape Palliser) in Te Whanganui-a-Tara (Wellington Harbour). Te Whanganui-a-Tara and the Tararua Ranges were named for our ancestor Tara-Ika. We descend directly from Tara-Ika (also known as Tara) and we are also known as Ngai Tara ki Mua Ūpoko o te Ika a Maui. The name Muaūpoko refers to our people as those who inhabit the area that is the known as the head of the fish and therefore describes the takiwā in which we have lived for over 1,000 years.

A map of our traditional area of interest can be seen in Figure 1.

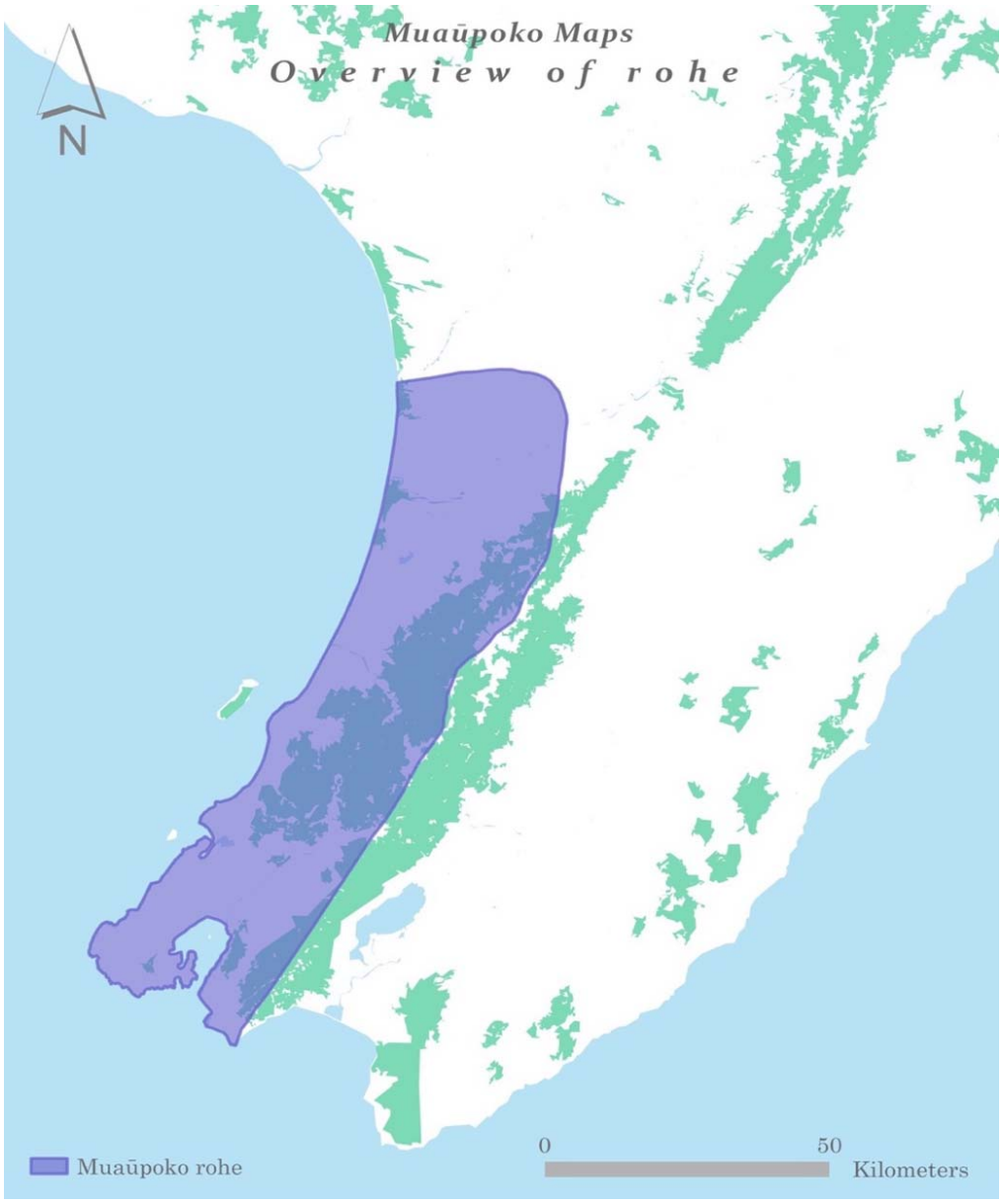


Figure 1: Muaūpoko traditional area of interest.

Our organisations constitution supports governance by a board of elected representatives, two from each of the seven existing hapū. The hapū are Ngai Te Ao, Ngārue, Ngāti Hine, Ngāti Pāriri, Ngāti Tamarangi, Ngāti Whanokirangi and Punahau.

In 2009, following a significant hui-a-iwi process, a Muaūpoko Iwi vision was developed and adopted. Respective MTA board's have adopted and upheld this iwi vision along with a set of imperatives to enact the vision on behalf of iwi members.

The Muaūpoko Iwi vision is

“Whakahono kia tu kaha Muaūpoko – Unite, stand strong Muaūpoko.”

The MTA board established the first strategic framework in 2008 and this has been reviewed and refreshed regularly since then. The current strategic imperatives are as follows:

1. promote and support tino rangatiratanga for Muaūpoko whānau, hapū and iwi
2. strengthen and retain the traditional, cultural, and spiritual values of whānau, hapū and iwi of Muaūpoko
3. protect, preserve and enhance Muaūpoko tānga, assets and taonga
4. represent Muaūpoko interests and support a stronger economic, educational, health, social and cultural base for Muaūpoko people.

These are supported by 12 strategic goals:

1. support hapū cultural revitalisation initiatives and structures, work with hapū to develop an environmental strategy
2. strengthen the paepae on Muaūpoko marae
3. develop and maintain a sustainable hapū funding programme
4. develop leadership opportunities for rangatahi
5. support Muaūpoko day celebrations (for example, Waitangi Day)
6. continue to strengthen MTA governance and operational capacity, systems and procedures
7. build strong communications with members
8. contribute to and leverage existing initiatives and/or relationships aimed at protecting and enhancing Muaūpoko natural resources and the environment
9. grow and protect the Muaūpoko asset base
10. develop a comprehensive iwi health and well-being strategy
11. Represent Muaūpoko interests at local and national forums and ensure the mana of Muaūpoko is always upheld

12. Continue to develop and maintain relationships with other Iwi, stakeholders, government agencies and private-sector organisations that enhance the ability of Muaūpoko to achieve its vision.

1.5 Assumptions and exclusions

This CIA has been completed based on the information provided in Section **Error! Reference source not found.**, the exercise of professional judgement and an in-depth knowledge of the Muaūpoko values and mātauranga. The following assumptions have been made to complete the CIA:

- The CIA is based on the AEE provided for the increased water take and works to construct the intake and pipe bridge. The reservoir construction works AEE and NoR to designate the site have not been provided, so no assessment of those activities has been completed, however reference to these key aspects of the scheme have been made for context.

- We assume the project description and associated plans accurately depict the project intent and scale.

1.6 Ka mua, ka muri: Looking back in order to move forward

While we have a wide area of ancestral connection and contemporary interest within our traditional rohe, as described in section 1.4.1 above, the Horowhenua block is known in contemporary times as the heartland of Muaūpoko (see Figure 2), it is centred around our taonga Punahau.

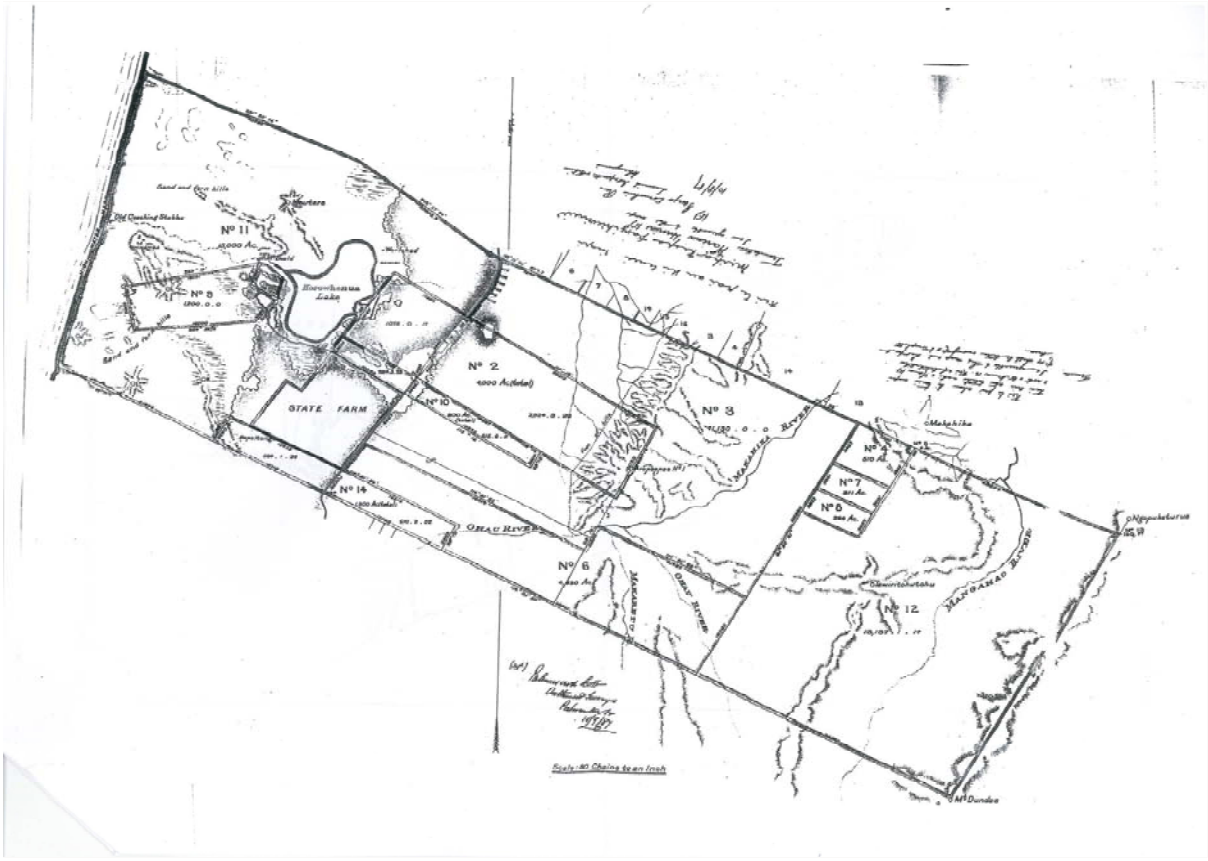


Figure 2: Muaūpoko heartland – the Horowhenua block. The Ohau Awa and proposed reservoir site is in our heartland.

These heartlands were subdivided by the Māori Land Court in 1886, as the result of pressures put on our ancestors by the Crown's acquisition tactics, the Wellington and Manawatū Railway Company's designs on the block, and, most of all, the threat posed by native land laws, which favoured partition and purchase over retention and rangatiratanga. It was completely Muaūpoko-owned land for many hundreds of years (along with a town development survey plan) which was used to establish the township of Levin (the name Taitoko was one of the Muaūpoko conditions of town establishment and sale of the land).

Our ancestors were never opposed – as we are not opposed today – to the settlement and development of the Horowhenua District, or to the introduction of infrastructure such as roads, bridges, and railways. However, we believe, as our ancestors did, that the development of such infrastructure should provide benefits equally to Muaūpoko and Pākehā. As our region was developed, our ancestors simply sought what was agreed under Te Tiriti o Waitangi, as we do today.

The High Court[3] has extracted principles from Waitangi Tribunal and Supreme Court decisions to incorporate into the RMA context. These help to define our rights and expectations for our relationship with HDC which, interestingly, align strongly with the outcomes our ancestors sought during the early development of the wider Horowhenua area. These principles include:

- partnership
- mutual obligation to act reasonably and in good faith
- active protection – under this principle, the Crown has an obligation to actively protect Māori interests (this principle may also require applicants to investigate alternative options which do not affect Māori relationships with resources)[4]
- mutual benefit – this incorporates enabling aspects for both Māori and non-Māori
- development – the Treaty is to be adapted to modern, changing circumstances
- rangatiratanga – recognising iwi and hapū rights to manage resources or kaitiakitanga over their ancestral lands and waters.

Our tribe's vision for the economic development of Muaūpoko in Horowhenua included the railway, Taitoko township and a bicultural society which would provide the capital and conditions for the development of our lands.[5]

When the railway line connecting Horowhenua and the wider district to Wellington was introduced in the 1880s, our ancestor (and a nominated leader of the time) Te Keepa Rangihiwinui, encouraged our people to embrace the initiative alongside the benefits it should have brought for our people. Being aware of the costs and perils of the court and land dealings, Te Keepa held off applying for a subdivision of our lands until an agreement was negotiated with the Crown for the railway line and a township on the Horowhenua block. As such, on 25 June 1886, Te Keepa proposed an agreement with the Crown that would establish a township and subdivision in Horowhenua. The agreement reached proposed:

- sell 4,000 acres for the township on both sides of the railway to the Crown at an agreed price (if the price could not be agreed it was to be determined by arbitration)

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[3] For example, Carter Holt Harvey v Te Runanga o Tuwharetoa ki Kawerau [2003] 2 NZLR 349 (HC).

[4] Te Runanga o Taumarere v Northland Regional Council [1996] NZRMA 77 (EC).

[5] David Armstrong, 'Muaupoko "Special Factors": Keepa's Trusteeship, the Levin Township Sale, and the Cost of Litigation', CFRT, 2015. Wai 2200 #A155, pp.3 and 8.

- reserve every tenth township section for Muaūpoko
- reserve to Muaūpoko, Lakes Horowhenua (Punahau) and Papaitonga (Waiwiri), the streams running from the lakes to the sea, and a chain of land around each of the lakes
- share trusteeship between council and iwi of public reserves (including 100 acres "as a garden") for the town beside Lake Horowhenua, a town square, and land for schools for all people
- apply to the Native Land Court for subdivision
- name the township Taitoko.[6]

Te Keepa and our people believed these terms were agreed and, on this basis, supported the application for subdivision.[7] This innovative partnership proposal – which reflects the manaakitanga of Muaūpoko towards an irrevocably changing and diversifying community – a vision for which was a mutually beneficial bicultural society where Māori and Pākehā could thrive together (as had been evidenced in the many lease arrangements with Pākehā for Muaūpoko land to that point) – was not honoured. In addition to paying less than half what the land for the township and railway was worth, the Crown refused to honour any of the conditions under which the township had been offered and verbally agreed. The bicultural township was dead – it became an exclusively Pākehā space. Native Minister Ballance did not want "natives mixed up in the town with Europeans".

After deducting land already alienated for the township block, railway land, and a block lost to clear Land Court debts (which had arisen as a result of trying, through Pākehā court systems, to protect the land itself), our people retained about 45,000 acres[8], however, the Crown and the courts soon blocked our path and continued to cheat us out of our land in the following decades.

The long delay in railway construction forced those seeking to open the district to look instead to roads, which could be built more quickly and cheaply by local labour. From the late 1870s, the formation of the inland road from Ōtaki to Foxton began (the forerunner to what is now State Highway 1) as settlers wanted an interior road to open large areas of undeveloped land (then still owned by our Muaūpoko ancestors) to settlement.

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[6] AJHR, 1896, G-2, pp.296-297, and; Malcolm McKinnon, 'Manawatū and Horowhenua places – Horowhenua', *Te Ara – the Encyclopedia of New Zealand,* http://www.TeAra.govt.nz/en/manawatu-and-horowhenua-places/page-9 The name 'Taitoko' is said to derive either from Te Keepa's father or from his daughter and heir.

[7] Waitangi Tribunal, *Horowhenua The Muaupoko Priority Report*, Wellington, 2017, p.205, and AJHR, 1896, G-2, pp.73-74.

[8] Waitangi Tribunal, *Horowhenua The Muaupoko Priority Report*, Wellington, 2017, pp.234-37 and 239-46.

When works on roads in the region began in 1878, county councils sought the co-operation of those iwi who owned land along the route, including Muaūpoko. We did not oppose road or rail, we simply sought to ensure development was sensitive to our ancestors concerns and would benefit all people, not just the Pākehā settlers. However, the process was fraught with issues. Manawatū County Council refused to compensate our ancestors for land taken for the road, did not undertake appropriate consultation and refused fair compensation for our labour.

The previous passages briefly describe the issues our ancestors faced when working in partnership with the Crown on major infrastructure development projects. Since then, there have been numerous further breaches of trust where our people have been exploited, from consultation and consent, to works undertaken on our traditional lands. We are immensely proud of our ancestors for staunchly maintaining our traditions and advocating for our rights, through what must have been an extremely turbulent time.

The Taitoko drinking water scheme is the largest drinking water infrastructure project within the Horowhenua and is occurring in our heartlands.

"We have worked hard, beyond reasonable pre-settlement and inequitably funded capacity, to meet our obligations as Treaty partners to HDC and ensure our rights and interests are provided for[9]."

[9] Diane Rump, Muaūpoko Chief Executive

2 Methodology

2.1 Communicating our values

We have compiled an expert team of Muaūpoko mātauranga advisors (representatives of our hapū) to oversee the development of this CIA. Kāhu Environmental, an environmental, planning and kaupapa taiao consultancy, was engaged to provide expert advice on compiling this document.

We have also been guided by advice and input from our Board of Trustees, whānau and rangatahi.

We acknowledge that the opinions of some individual hapū and whānau members may differ from those expressed in this assessment. However, we believe it supports and gives effect to the aspirations in the MTA strategic plan[10], is best for our whānau, hapū and iwi, represents our tikanga and lore, and gives effect to our rights under New Zealand's planning frameworks.

We drew the knowledge in this CIA from the following sources:

1. oral kōrero shared by the Kāhui Ārahi Mātauranga rōpū, advisors to MTA and the Muaūpoko Ki Uta Ki Tai Environmental Project Team
2. MTA Trust Board
3. Muaūpoko Treaty evidence and other documents of importance to us (education, planning, environment, and health)
4. a series of site visits, workshops and meetings with Horowhenua District Council representatives
5. interpretation of other technical assessments delivered by the project

We've condensed our kōrero into a values framework shown in a table in each subsection of section 4. This framework enabled us to assess the level of the project's effects on Muaūpoko values.

[10] Muaūpoko Tribal Authority Board Strategic Plan https://muaupoko.iwi.nz/wp/wp-content/uploads/2014/02/Appendix-A.pdf

2.2 Legislation considered in our assessment

To develop this framework, district, regional and national planning frameworks where integrated where they aligned with our values. For example, the principles of Te Mana o te Wai (National Policy Statement for Freshwater Management (NPSFM)) and aspects of Te Ao Māori One Plan objectives can be found therein.

This CIA can therefore be used to understand our perspective on whether the project recognises and provides for the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, wāhi tapu, and other taonga (Section 6(e) of the RMA), how particular regard has been had to kaitiakitanga (Section 7(a) RMA) and how the principles of Te Tiriti o Waitangi have been taken into account (Section 8 RMA). The CIA also contributes to the need for the project to achieve sustainable management for future generations.

2.2.1 National Policy Statement for Freshwater Management 2020

The National Policy Statement for Freshwater Management 2020 (NPSFM) requires a completely different approach to freshwater management. Te Mana o te Wai is now the fundamental concept for all freshwater decision-making, and HDC must give effect to it. Councils must also actively involve tangata whenua in all freshwater management, including decision-making. This national policy statement is of particular focus for Muaūpoko given the exemption of Lake Horowhenua for the purposes of horticulture and the impacts of these activities on the catchment, waterways and Muaūpoko taonga. Hence giving effect to this concept is critical in terms of the management and design of all aspects of the scheme. Te Mana o te Wai encompasses six key principles relating to the role of tangata whenua in freshwater management:

Six Principles

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 obligations 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 obligations of all New Zealanders to manage freshwater in a way that ensures it sustains present and future generations

Care & Respect

The responsibility of all New Zealanders to care for freshwater in providing for the health of the nation

Te Mana o te Wai also embodies a hierarchy of obligations. The single objective of the NPS-FM is to ensure that natural and physical resources are managed in a way that prioritises:

1st
- The health and well-being of water bodies and freshwater ecosystems

2nd
- The health needs of people (such as drinking water)

3rd
- The ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future

Other significant policy provisions of the NPSFM are set out below.

Policy 2

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

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.

Approaches relevant to implementing these policy provisions of the NPSFM include:

3.4 Tangata whenua involvement

(1) Every local authority must actively involve tangata whenua (to the extent they wish to be involved) in freshwater management (including decision-making processes), including in all the following:

(a) identifying the local approach to giving effect to Te Mana o te Wai

(b) making or changing regional policy statements and regional and district plans so far as they relate to freshwater management

(c) implementing the National Objectives Framework (**see** subclause (2))

(d) developing and implementing mātauranga Māori and other monitoring.

(2) In particular, and without limiting subclause (1), for the purpose of implementing the NOF, every regional council must work collaboratively with, and enable, tangata whenua to:

(a) identify any Māori freshwater values (in addition to mahinga kai) that apply to any FMU or part of an FMU in the region; and

(b) be actively involved (to the extentthey wish to be involved) in decision-making processes relating to Māori freshwater values at each subsequent step of the NOF process.

3.5 Integrated Management

1. Adopting an integrated approach, ki uta ki tai, as required by Te Mana o te Wai, requires that local authorities must:

(a) recognise the interconnectedness of the whole environment, from the mountains and lakes, down the rivers to hāpua (lagoons), wahapū (estuaries) and to the sea; and

(b) recognise interactions between freshwater, land, water bodies, ecosystems, and receiving environments; and

(c) manage freshwater, and land use and development, in catchments in an integrated and sustainable way to avoid, remedy, or mitigate adverse effects, including cumulative effects, on the health and well-being of water bodies, freshwater ecosystems, and receiving environments; and

(d) encourage the co-ordination and sequencing of regional or urban growth.

2.2.2 Horizons One Plan Te Ao Māori

Horizons Regional Council has yet to undertake Plan Change 3 to give full effect to the NPSFM and Te Mana o te Wai. However, Objective 2-1 of the Horizons One Plan is of note regarding involvement of hapū and iwi resource management, with Policy 2-1 and Policy 2-2 providing further provisions to support the Objective.

Objective 2-1: Resource Management

Objective 2-1 (a)

To have regard to the mauri of natural and physical resources to enable hapū and iwi to provide for their social, economic and cultural wellbeing.

Policy 2-1: Hapū and iwi involvement in resource management

The Regional Council must enable and foster *kaitiakitanga* and the relationship between *hapū* and *iwi* and their ancestral *lands*, *water*, *sites*, *wāhi tapu* and other *taonga* (including *wāhi tūpuna*) through increased involvement of *hapū* and *iwi* in resource management processes including:

(h) involvement of *hapū* or *iwi* in *resource consent* decision-making and planning processes in the ways agreed in the memoranda of partnership and *joint management agreements* developed under (a) and (f) above, and

(i) the Regional Council advising and encouraging *resource consent* applicants to consult directly with *hapū* or *iwi* where it is necessary to identify:

(i) the relationship of Māori and their culture and traditions with their *ancestral lands*, *water*, *sites*, *wāhi tapu* and other *taonga* (including wāhi tūpuna), and

(ii) the actual and potential *adverse effects* of proposed activities on those relationships.

Objective 2-1 (b)

Kaitiakitanga must be given particular regard and the relationship of hapū and iwi with their ancestral lands, water, sites, wāhi tapu and other taonga (including wāhi tūpuna) must be recognised and provided for through resource management processes.

Policy 2-2: Wāhi tapu, wāhi tupuna and other sites of significance

(a) Wāhi tapu, *wāhi tūpuna* and other *sites* of significance to Māori identified:

(i) In the Regional Coastal Plan and district plans,

(ii) as historic reserves under the Reserves Act 1977,

(iii) as Māori reserves under the Te Ture Whenua Māori Act 1993,

(iv) as sites recorded in the New Zealand Archaeological Association's Site Recording Scheme, and

(v) as registered sites under the Historic Places Act 1993

must be protected from inappropriate subdivision, use or development that would cause *adverse effects* on the qualities and features which contribute to the values of these sites.

(b) The Regional Council must ensure that resource users and contractors have clear procedures in the event *wāhi tapu* or *wāhi tūpuna* are discovered.

2.3 Assessing the magnitude of effects of the project on our values

We determine the magnitude of effects of the activities (including construction and ongoing operation) resulting from the proposed development on our values, both in:

1. the absence of any effects management actions
2. after any effects management actions have been applied.

Our assessment applies a six-scale classification (shown in Table 1) to the magnitude of effects on our values. Magnitude being a measure of change/alteration from the existing baseline state.

Assessing magnitude of effects takes into account:

1. the level of confidence that effects will occur in the way anticipated
2. the spatial scale and extent of the effects
3. the duration of the effect (temporary versus permanence)
4. whether the potential effect is reversible
5. the timing of the effect in relation to environmental cycles, patterns and the maramataka.

Table 1: Magnitude classification system description.

Magnitude	Description
Very high	Total loss of, or very 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 may be lost from the site altogether; AND/OR Loss of a very high proportion of the known value 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 values or range of the element/feature.
Moderate	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 values or range of the element/feature.

Low	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 value or range of the element/feature.
Negligible	Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; AND/OR Having negligible effect on the known value or range of the element/feature.
Positive	Enhancement above baseline condition. Change is beneficial to values and attributes AND/OR promotes the value or range of the element/feature.

2.4 Results

To determine the final level of effects the project will have on our values, we apply a matrix approach shown in Table 2. The matrix results guide us in assessing if a net gain, very low, low, moderate, high, or very high level of impact may occur on our values. Where the effects from the project have not been reduced to an acceptable level, further avoidance, remediation, or mitigation is required, and we will be working with HDC in an ongoing manner to ensure a pathway is set up to address these matters. If that is not possible or practical, we look to cultural offsetting or compensation applied elsewhere.

Table 2: Level of effects matrix.

		Cultural value				
		Very high	High	Moderate	Low	Negligible
Magnitude	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

3 Project shaping

3.1 Drinking Water Supply Options Assessment

HDC developed a Water Supply Augmentation Operational Framework[11] (WSAOF) to assess water supply options for the Taitoko community and identify a preferred option for securing sufficient drinking water to meet the community's projected needs and improve the security and resilience of the drinking water supply. The various options that were considered and taken forward are summarised below.

3.1.1 Bulk raw water storage using existing consented allocation

This option involves construction of a large (multi-day supply capacity) storage for raw (untreated) water. This would typically involve a large reservoir constructed off-river to store water for later use either to meet shortfall between community demand and supply from the source (e.g. below low flow, or high turbidity), or to meet demand when source water supply is interrupted (e.g. during an earthquake). This option assumes the existing consented allocation and the Council's assessment based on projected growth shows that annual demand will exceed the allocation currently consented at some point between 2030 and 2036. After this time, an additional consented water source would be required to fill the reservoir.

3.1.2 Ohau Awa water harvesting and supplementary allocation

The amount of water available for allocation from the Ohau Awa is prescribed in the water allocation framework in the One Plan. The HRC framework is summarised in Figure 3.

[11] Levin Water Supply. Water Supply Augmentation Operational Framework. Horowhenua District Council REVISION 3 (March 2023)



Figure 3: Summary of One Plan Allocation Policies and Rules (Source: WSAOF)

For the Ohau Awa, HDC identified that there is very little water remaining from the core allocation and that there should also not be additional water sought when the awa is below low flow. HDC's assessment showed that there was sufficient water available under the supplementary allocation to meet the Taitoko community needs for the 50-year planning timeframe being considered. However, because harvest can only occur when the river is above median flow, the option must be implemented in conjunction with large scale raw water storage.

3.2 Other Surface Water Resources considered by the WSAOF

These options involved sourcing additional water from a different surface water catchment. HDC considered ten catchment areas and found that only four surface water resources in the area that could potentially provide sufficient water to meet the future water demand of the community. These were the Waikawa, Upper Mangahao, Tokomaru and Manawatū Awa. Of these, all but

the Waikawa were discounted on the basis of distance, cultural concerns around trasfer of water between catchments and water quality (or a combination of these). The Waikawa Awa was seen as a potentially viable source, however convayance routes are 15 – 20km long and bulk storage would also be required to meet community needs beyond 2034. Furthermore, HDC identified that the transfer of water between catchments and water quality issues would also need to be addressed with this option.

The assessment identified that a key consideration with utilising other surface water resources is that the impacts of climate variability on the four rivers considered are likely to be similar to those for the Ohau Awa. However, in comparison with the Ohau, these awa are likely to experience periods where abstraction is restricted that are more frequent and more persistent.

3.2.1 Groundwater Bores

This option involves constructing and abstracting water from a series of groundwater bores within, or close to, the Taitoko water supply area. HDCs assessment considered the Ohau catchment surface and groundwater as a single resource. Therefore, a groundwater abstraction will be treated as if it was directly from the Ohau Awa (which is already fully allocated), unless conclusively shown that water from the bore has no interaction with surface water. In addition to this, the interaction of surface and groundwater means that any further groundwater abstraction would have a potential adverse effect on Punahau/Lake Horowhenua.

HDC found that on the basis of available information, and considering the shortfall in water supply required to meet Taitoko demands over the 50-year timeframe identified by the assessment, abstraction would need to be an order of magnitude greater than current groundwater allocation. Therefore, it is likely that such a level of abstraction could potentially have a significant adverse impact on Punahau/Lake Horowhenua. The cost of determining conclusively that the groundwater source does not interact with surface water would also be prohibitive, with no guarantee the investigation would yield a viable alternative. If groundwater could be shown to be a vailable source, the time and cost involved in developing the groundwater abstraction would also make this option unattractive. Muaūpoko were uncomfortable with a groundwater approach, the risk to our taonga, Punahau, was too great

3.2.2 Rainwater Harvesting

Rainwater harvesting is an option to be applied at the household or property level and is aimed at reducing demand on the community water supply. Rainwater collection tanks are installed at properties and attached to the dwelling or building roof. Rainwater is collected and used for non-potable and/or potable water use. To avoid the need for complex treatment, regulatory oversight, risks of non-potable water being used, and costs at the household level, HDCs assessment assumed that rainwater harvesting would be used for non-potable uses only.

HDC identified a number of benefits from harvesting rainwater (e.g. reducing load on stormwater system, reducing household demand for non-potable uses, increasing awareness of water conservation issues) but also a number of issues that require management when implementing the option (e.g. potential for building consent, does not address peak demand). Overall it was found that, if widely adopted, rainwater tanks could reduce overall annual demand on any water supply scheme. However, rainwater stored at individual properties is expected to be used in the early stages of an extended dry period or during peak demand and therefore, this option does not provide meaningful storage to reduce peak community demand. As a result, regardless of their adoption, the community supply scheme will still need to meet the projected peak daily demand. Muaūpoko are supportive of the roll-out in subdivisions of these micro-stroage facilities but agree they do not provide a viable, resilient community scale solution.

3.2.3 Wastewater Treatment and Reuse

This option would involve treating wastewater at the Taitoko Wastewater Treatment Plant to a sufficient level that it could be used for either potable or non-potable uses. HDC found that, while technicaly feasible, no systems were currently in use in Aotearoa that treat wastewater to drinking quality (potable) for subsequent reuse. Treating wastewater for re-use as drinking water purposes would not be acceptable to Muaūpoko and the general community. In recognition of cultural values and community expectations (as well as timeframe for investigation), HDC concluded that this option would not be progressed.

Non-potable reuse would involve use of treated wastewater by large water users and/or reticulation to households for non-potable use. The Council found that local large users were unlikely to utilise water not meeting drinking water standards (e.g. Allied Meats) and that other potential uses (e.g. public amenity, parks, gardens, swimming pools) were not high enough to significantly reduce water demand. Significant costs were also identified for providing non-potable water (from wastewater) to the community for non-potable outdoor use due to the requirement for a new dedicated reticulation system. For these reasons, HDC found that this option for water supply was not viable.

3.2.4 Seawater desalination

This option involves extracting seawater and treating it via a desalination process to produce potable water. This treatment process utilises proven technology and is used widely across certain areas of the world; however, it is not used to produce drinking water anywhere in Aotearoa. The key issues with this option for water supply are the capital and operating costs, energy consumption (process requires significant electricity input) and process by-products requiring management (e.g. brine). As a result, the Council and Muaūpoko has not comnsidered this option any further.

3.2.5 Assessment of Options

HDC used a multi-criteria analysis that adopted a "traffic light' assessment process and a qualitative approach to each criterion. The assessment criteria represent the key considerations in determing the preferred option and comprised the following:

- Water availability;
- Cultural values;
- Supply resilience;
- Environmental effects;
- Source water suitability; and
- Economics.

The assessment of the options against the above criteria yielded an overall score and ranking for the options. The overall score was determined by assuming all criteria carried equal weigh and were assigned a score based on the 'traffic light' colour[12] assessed for the option. The option with the highest score was considered the preferred option. The multi-criteria assessment for each option is summarised in Table 3.

Table 3: Assessment of Options and Overall Ranking

	Availability of Water	Cultural Values	Supply Resilience	Environmental Considerations	Source Water Suitability	Economics: Capital and operating costs	Score	Ranking
Bulk Raw Water Storage Using Existing Consented Allocation							22	3
Ohau River Water Harvesting (Reservoir) + Supplementary Allocation							28	1
Other Surface Water Resource: Waikawa Stream							16	5
Other Surface Water Resource: Upper Mangahao							14	8
Other Surface Water Resource: Tokomaru River							14	8
Other Surface Water Resource: Manawatu River							14	8
Groundwater Bores							14	8
Rainwater Harvesting							24	2
Wastewater Treatment & Re-use: Potable Reuse							14	8
Wastewater Treatment & Re-use: Bulk non-potable							16	5
Wastewater Treatment & Re-use: Reticulated non-potable							14	8
Seawater Desalination							16	5

Source: WSAOF

It can be seen from Table 3 that the preferred option is water harvesting from the Ohau Awa when above median flow and a bulk raw water storage reservoir. Rainwater harvesting and the bulk reservoir alone are the second and third ranked options, respectively. HDCs assessment

[12] A score of 1 for red; 3 for orange and 5 for green.

concluded that while rainwater harvesting is already being implemented in developments such as Tara-Ika, and ranked highly, it has little scope for meeting future demand and therefore would only be considered, at best, a component of the overall solution. The bulk water storage reservoir alone ranking third highlighted the importance of the bulk storage reservoir component of the preferred option.

3.3 Muaūpoko position

We are comfortable that over-all HDC has come to the most prefered solution however we are not comfortable with the means in which they arrived there. The cultural values score was not designed or ranked by Muaūpoko. We have made enquiries within HDC but cannnot understand who has developed this assessment. It is inappropriate for HDC or any associated consultants to manage cultural scoring. This must be done by the iwi themselves or their identified representatives.

3.4 Preferred Option Development – Reservoir Location

HDC used a constraints mapping exercise to identify the preferred site for the best practicable option. This exercise aimed to avoid Outstanding Natural Features, Landscape Areas and Important Ridgelines, known fault lines, the Natioanl Grid Transmission Line corridor while ensuring the reservoir is located out of the active river corridor and floodplain, The constraints mapping is shown in Figure 4. Unfortunately our people were not involved in this constraints mapping exercise and our wāhi tapu not considered.

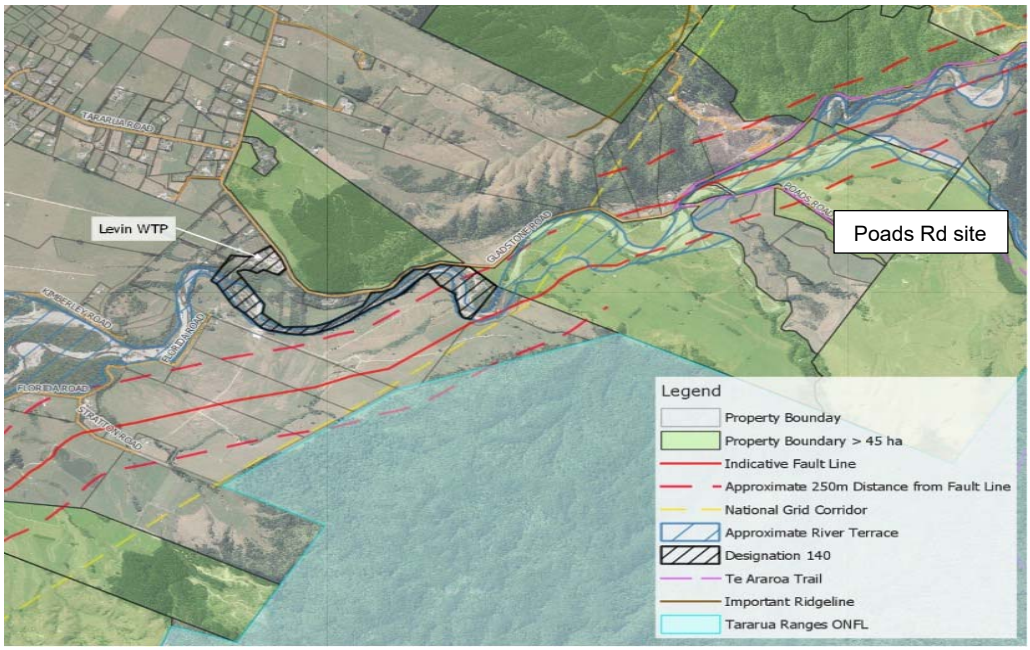


Figure 4: Constraints Mapping to Identify Potential Reservoir Sites (Source: WSAOF)

HDC identified three sites on the north side of Ohau Awa as of sufficient size, however, these sites were described as having too steep a terrain, forestry cover and / or have watercourses present. According to HDC, construction on any of these sites would have made consenting difficult and more expensive than other sites under consideration. Three further sites were identified on the southern side of the Ohau. Of these, HDC identified the site off Poads Road as the preferred site. No further assessment of the other two sites as to why they were less preferred for the project than the Poads Road site was provided for our consideration. We believe HDC had previously purchased the Poads Road site with the intention developing the property as a bulk off-river water storage reservoir. The purchase was completed prior to the development of the WSAOF, the associated MCA and preferred site selection. We expect the scenario was pre-determined to some extent.

HDC refers to further assessment of the Poads Road site having been done since purchase, demonstrating that the portion of the site which would be used for the reservoir is under exotic grassland and that there are no natural wetland features or areas of rare, threatened or at-risk habitats directly within the constructuion zone. However we understand that since further investogations have taken place, lizards habitat has been identified and a small wetland.

3.5 Engagement with Muaūpoko

Muaūpoko have not been involved in the early process to identify the preferred drinking water supply options or selecting the preferred option for the location of the proposed storage reservoir. It is difficult to come into a project on the back end and undertake a cultural impact assessment therefore we have taken the time to analyse and document the early part of the process. We support the preferred drinking water option (but not the process to get there where a cultural values MCA was undertaken without our cultural expert input) however we have some discomfort around the assessment taken to determine the location of the reservoir. It does seem that a full and proper Best Practicable Option assessment was not completed, and a land purchase was made prior to this being completed. We have not undertaken a full assessment of our values over the reservoir as this is out of the scope of this particular CIA.

Informal updates of the process have been provided by HDC throughout this time to our leaders, we have been prevented from participating to our fullest extent due to our capacity constraints and lack of funding for participation that would allow us to secure external support such as has been the case for the development of the CIA. We do however acknowledge the HDC has commissioned this CIA which has allowed us to procure external support for its development.

Going forward into this and other projects we make the following key recommendation to HDC:

Engage and support our capacity at the beginning of projects prior to large financial decisions being made, it is too late for a meaningful partnership to form if we are included at the consenting end of the project

4 Analysis of our values

The following sections describe our values, the state of those values within our landscape, and potential and actual adverse effects of the project on the values. Each section is summarised into a values framework, which presents our kōrero in a useable form.

Our connections with valued waterways, sites and taonga has not diminished with the passing of time or succession of generations. Our values remain within our cultural practices and mātauranga passed down through generations, despite human interventions (e.g., deforestation, drainage and stop-bank schemes) removing physical traces, or degrading, our natural resources. Thus, the values assessed within this CIA are assessed in two parts:

1. The physical presence of species and ecological qualities of waterways; and,

2. The effects of the project on our traditional, cultural and spiritual values, and our mātauranga and practices.

4.1 Our worldview

Ranginui, the sky father, and Papatūānuku, the earth mother, gave rise to all life forms. The early stages of life are known as Te Kore (the void) and Te Pō (the darkness). Te Kore was the state of non-existence and emptiness but had possession of vast potential for life. Te Pō and Te Kore have many forms representing passages of time where life was created. For example, the emptiness and darkness of mind; with no light there was no knowledge.

The energy of Ranginui and Papatūānuku combined and so many children came to be in Te Pō, however due to the close and continual embrace of Rangi and Papa, nothing would grow. After much discussion and glimpses of what could be in the outside world, the children decided to separate their parents. Many children tried, but Tāne Māhuta finally managed to complete the separation. The separation brought in Te Ao Marama, the world of light and growth. The tears of Rangi – being separated from Papa – caused a great flood. Today, when it rains, it is said that Rangi is shedding tears for his beloved wife. The mists of the land are the grief of Papa rising up. The world became clothed in Tāne's children – trees, birds, and insects. Tāne realised the human form required a female, whom he created and was known as Hine-ahu-one. It was Tāne who retrieved three baskets of knowledge from the highest of the twelve heavens: te kete tuatea (basket of light or present knowledge), te kete tuauri (basket of darkness or things unknown), and te kete aronui (the basket of pursuit or knowledge we currently seek).

Ruaūmoko, the youngest of gods, was still at Papa's breast when the separation occurred and was left with her as she was turned to keep her comfort in the underworld. Ruaūmoko is the god of earthquakes and volcanic activity, that constantly war against us in every age. Tāwhirimātea,

god of the winds, rails against the separation of Rangi and Papa and often seeks to devastate the forests and our homes which we need to survive. Tangaroa, god of the sea, had his children strewn by the fury of Tāwhiri across the land and depths of the ocean. This is how reptiles and fish evolved. Rongomatāne, god of cultivated foods and peaceful arts, and Haumietiketike, god of wild foods, were hidden by Papa from the wrath of Tāwhiri beneath the soil, there they stayed and remain today. Tūmatauenga, god of war, fought with Tāwhiri and then waged war on his brothers and their children for not assisting him. None escaped the attacks, their children were caught and consumed as food, removing their tapu and making way for the eventual superiority of our human form.

Our creation kōrero describes how we view the world as holistically related through whakapapa. We, as tangata whenua, belong and relate to the whenua, wai and moana. It describes our understanding of the interrelationships between different realms of the environment and the natural phenomena surrounding us.

Within all creation is mauri, the life force that generates, regenerates, provides resilience and upholds creation. It is the bonding thing that knits all the diverse elements together to sustain life over time.

Mauri encompasses the living health of our soils, mountains, ngahere, awa, repo, taonga species, our people, our wāhi tapu and their interconnectedness (ki uta ki tai) across the landscape.

- We can measure the physical health of our environment using indicators relating to the qualities of our soils, pollution in our awa, the health of populations, species, communities, and ecosystems. We rely on other technical assessments, freshwater ecology, terrestrial ecology, water quality and hydrology to assess the physical aspects of mauri.

- The spiritual qualities of mauri includes concepts such as tapu and noa that keep us safe, it speaks to your puku, where we have an intrinsic knowing that something is wrong or, in fact, thriving in the environment that we relate to. It also includes our ability to practice our culture and spirituality. Only our people can assess this aspect of mauri.

- Our traditional values relate to concepts such as natural character and visual values, the way the land is managed and how it looks. This is critical to our ability to connect with our whakapapa. We rely on a mixture of natural character, visual assessments and our people to inform this aspect of mauri.

Kaitiakitanga emerges from the concepts of mauri and whakapapa. Kaitiakitanga encompasses guardianship, preservation, conservation and protection. In its simplest form, it is the act of

caring for the physical, ecological and spiritual well-being of our lands and waterways. Ensuring harmony is maintained against elements that would cause imbalances.

Traditionally, our atua are our kaitiaki being one with the elements and responsible for their maintenance. Their actions can sometimes push and pull against harmony and balance; ultimately, however, they maintain resilience and the mauri of the environment. The concept of kaitiaki related purely to our atua and the spiritual and physical beings described above. For us, kaitiakitanga was just something we did as part of everyday life to stay in harmony with our surroundings. However, due to the scale and pace of destruction of our traditional waters, whenua and sites, and the impacts on our people beginning in the 1800s, the process of colonisation has severely unbalanced our world. We, as tangata whenua, now take a more critical role acting as kaitiaki to restore the imbalances. We hold kaitiaki responsibilities across our whole traditional rohe. The health and well-being of our people are intimately linked with the health of the environment – as we work to heal our whenua, so in turn, will our whenua heal us.

Table 4: Our values associated with our atua.

Value	State	Class	Potential and actual effects
Te Kete Aronui (Ta Uta Uta) – Our growth and knowledge	Our iwi is pre settlement, therefore our capacity and capability is stretched and our knowledge base is only slowly regenerating. It is key to our holistic health, te whare tapa wha of our people that we can be leaders and knowledge holders of all that concerns our lands, waterways and people. The knowledge transfer opportunities within the project are significant but, currently, we are missing them due to limited capacity. We constantly make this point and advocate for resolution. It is essential to authentic Tirirti and project partnerships, and the enactment of agreed project values.	**Very high**	**Construction phase** *Inability to pursue our growth and knowledge as an iwi in the construction phase due to capacity constraints.* Muaūpoko is under-resourced and our capacity over-burdened through historical and contemporary actions of the Crown. This will have an adverse effect on our people being able to partner effectively with Horowhenua District Council, participate authentically in the project development and implementation, and protect our rights and interests. This adverse effect is potentially reversible with support from HDC that recognizes our position in our treaty settlement process and extensive treaty breeches from the past (and ongoing).
			Operational phase *Inability to pursue our growth and knowledge as an iwi in the operational phase due to capacity and capability constraints.* Muaūpoko is under-resourced and our capacity over-burdened through historical and contemporary actions of the Crown. This will have an adverse effect on our people being able to participate authentically in the ongoing management of the project and protect our rights and interests. The risk is compounded if Muaūpoko are unable to participate fully in the construction phase.
Connections with and between our atua	The way our atua interact and our connections with our atua shape our day-to-day lives. This involves the way we	**Very high**	**Construction phase** *Disruption of the relationship between atua, kaitiaki and the environment during the construction phase of the project.*

teach our tamariki, what we teach them, how we manage our homes, our marae, celebrations and tangihanga. It shapes our relationships, kai gathering practices, traditions, and the way we move around our environment.			The project has the potential to tip atua kaitiaki out of balance, scar Papatūānuku and take her lifeblood. Potential effects include impacts on aquatic ecology habitat from works in waterbodies, sediment from construction water and the destruction of individuals with endangered species status. Groundwater and surface water hydrology will be affected by diversion works, and sedimentation will occur from works in the riverbed. The construction of the water intake structures could have spiritual and/or physical consequences for our taonga and our identity as an iwi. **Operational phase** *Disruption of the relationship between atua, kaitiaki and the environment during the operational phase of the project.* The project has the potential to irreversibly or reversibly tip atua kaitiaki out of balance. This could include adverse impacts on taonga populations because of the long-term impact on hydraulic surface and groundwater flows in the catchment or loss of aquatic habitat, essentially breaching tikanga, that could have spiritual and/or physical consequences for our taonga and our identity as an iwi.

Table 5: Magnitude assessment – Our atua.

Value	Activity / Effect	Magnitude WITHOUT management	Reasoning	Proposed effects management	Magnitude WITH management
Construction phase effects					
Our growth and knowledge.	The inability to pursue our growth and knowledge as an iwi in the construction phase due to capacity constraints. **Confidence:** High **Scale**: Effects MTA and our people	Moderate	We are kaitiaki in our rohe, we have many significant sites and our ability to manage them has been severely impacted by past and ongoing Crown actions. Our capacity must be	We are effectively supported so our people (whānau, landowners and various Muaūpoko groups) and representatives can demonstrate and lead Muaūpoko-	Positive

Value	Activity / Effect	Magnitude WITHOUT management	Reasoning	Proposed effects management	Magnitude WITH management
	Duration: The planning and construction phases of the project Reversible: Yes **Timing**: Ongoing and consistent challenges at all phases of the project		holistically supported so we can authentically partner, participate and protect our values as Te Tiriti partners. The construction works are relatively moderate in scale and thus the magnitude of effects is considered moderate rather than high.	tanga kaupapa in the project, such as: • implementation of our tikanga in the project such as karakia when our kaitiaki see necessary and installation of a mauri stone • participate in archaeological monitoring and overseeing environmental practices • participate in ecology and water-quality surveys • lead a cultural health assessment process for our iwi • record wai and taonga monitoring data in Muaūpoko's online data capture platform.	
Connections with and between our atua.	Disruption of the relationship between atua, kaitiaki and the environment during the construction phase of the project. **Confidence:** Low **Scale**: Local awa, population or community **Duration**: Months or permanent depending on the type of disruption **Reversible**: Depends on type of disruption **Timing**: During major earthworks	Moderate	Unexpected events, such as a heavy storm inducing ESC blowouts, accidental chemical or hydrocarbon spills, or accidental wildlife deaths remain a risk in infrastructure projects in waterways, despite good environmental management procedures and staff training initiatives. The is a very low occurrence rate and thus the effect is	Robust planning and feedback procedures should be included in the Sediment Erosion Control MP, and Ecological MP. At a minimum, the plans should include: • Descriptions of pre-construction wildlife surveys, including nest surveys in appropriate seasons, lizard surveys prior to vegetation clearance, aquatic de-fishing, and relocation prior to works in the Ohau Awa.	Negligible

Value	Activity / Effect	Magnitude WITHOUT management	Reasoning	Proposed effects management	Magnitude WITH management
			considered moderate (or low with good preventative on site measures).	• Oversized sediment-erosion control devices to protect to the Ohau Awa • Spill response procedures. • Protocols and resourcing for communication and inclusion of our representatives in each of the management plans.	
Operational phase effects					
Growth and knowledge.	The inability to pursue our growth and knowledge as an iwi in the operational phase due to capacity constraints. **Confidence**: Moderate **Scale**: Effects both MTA and LHT, our key iwi organisations **Duration**: The ongoing operation the water take Reversible: Yes **Timing**: Ongoing	Moderate	The ongoing operation will require less engagement capacity from our representatives but on more ciritical Kaupapa such as how to manage water take during low flow. We have less visibility over this as the actions required are multiple years away.	Throughout the project, we aim to participate in the management of the project environment. If managed well in the construction phase, this capacity can then be moved into our participation in ongoing operational management. This capacity is comparatively lacking due to Muaūpoko's past exclusion from participation in resources management decisions and capacity building must be supported.	Positive
Connections with and	Disruption of the relationship between atua, kaitiaki and the environment.	High	Wai is our lifeblood, it is highly interconnected, and it is severely	To manage the effects on habitat, the health and wellbeing of the	Low

Value	Activity / Effect	Magnitude WITHOUT management	Reasoning	Proposed effects management	Magnitude WITH management
between our atua.	**Confidence:** High **Scale:** Downstream of the water take **Duration:** Long-term Reversible: Yes **Timing:** Years after operation begins		degraded in our rohe. We are particularly concerned about takes during low flow events. Takes during low flow will have the following effects on the Ohau Awa - Degradation in habitat and thus the mauri or lifeforce of the awa at the time taonga species are in the most stress, takes below low flow have the potential to reduce flow by up to 18% and thus has a significant impact on habitat availability for the area between the intake and Makahika Stream, the impacts on habitat start to reduce after this time however still exist. - Reduction in habitat includes wetted width, riffles and runs - Sediments and algae are more likely to build up and reduce habitat where flows	awa, a cultural values restoration offset plan should be undertaken at locations identified by Muāupoko and HDC. The offset package should include opportunities for our kaitiaki to be involved in the restoration and enhancement work. The effects of the water take on the mauri of the Ohau Awa should be appropriately offset through the restoration. The restoration initiative must ensure: - actions must be undertaken in the vicinity of the water take - the cultural values associated with habitat impacted by the project activities will be similar or the same in the enhancement location so that overall a no net loss, and preferably a net gain can be achieved, - the positive outcome will last at least as long as the impact of the project, preferably in perpetuity	

Value	Activity / Effect	Magnitude WITHOUT management	Reasoning	Proposed effects management	Magnitude WITH management
			are reduced and contaminants more concentrated	- the habitat enhancement is designed and implemented in accordance with an understanding of how Muaūpoko are connected to the awa, Muaūpoko understanding of Te mana o te Wai and interconnects of wai, and in accordance with our tikanga. The project should require a cultural habitat offsetting management plan endorsed by Muaūpoko that - sets out baseline information on habitat and cultural values impacted by the project - includes clear objectives and performance criteria which demonstrate how the requirements set out will be addressed - identifies the monitoring approach that will be used to demonstrate how the matters set out have been address over an appropriate timeframe We also recommend an adaptive management strategy (managed by HDC and the mana whenua group) that continue to implement	

Value	Activity / Effect	Magnitude WITHOUT management	Reasoning	Proposed effects management	Magnitude WITH management
				efficient water management strategies over the lifetime of the consent including but not limited to - investing in and supporting community to install rainwater tanks for non-consumptive sues (including in new plan changes) - reusing wastewater for beneficial uses and subsequent reduction in freshwater takes - continual update of best management practice so takes during low flows can be minimized further - continual improvements are made to the network to minimize leakage - energy use is minimized	

4.2 Our whakapapa

Our whakapapa originates with our atua. Our ancestors who reached Aotearoa during the waka migration from our ancestral homelands in Hawaiki are also an integral part of our whakapapa. We recognise Kupe (an early adventurer), Toi-te-huatahi (Toi the explorer, the father of Whātonga), and Whātonga (a captain of the Kurahaupō waka) as our eponymous ancestors. Our story of Kupe is considered an account of our origins.

Kupe, a chief from Hawaiki, argued with Muturangi, whose pet octopus had stolen bait from Kupe's fishing lines. Kupe boarded the waka Matahourua, while his companion Ngake (Ngahue) boarded the waka Tawirirangi (Tawhirirangi). The pair set sail in pursuit of the octopus to Aotearoa where it was finally killed at a place known as Arapaoa. Kupe travelled on, naming places in Aotearoa along the way. The two islands in Te Whanganui-a-Tara were named for his daughters (or nieces), Matiu and Mākaro. Kupe discovered greenstone in the South Island and returned to Hawaiki from Hokianga. Upon his return, Kupe informed his (our) people of the new land he had discovered, including his nephew Turi, who then captained the Aotea waka to these shores.

Meanwhile, Whātonga was aboard the Kurahaupō waka, which arrived on the west coast at Tongapōrutu. Whātonga found his grandfather Toi-te-huatahi at Whakatāne, then ventured onwards to Heretaunga where he settled. Whātonga sent his sons, Tara-Ika and Tautoki, to Te Ūpoko o te Ika (the head of the fish of Maui/southern North Island) to explore and live.

The eldest son of Whātonga, Tara-Ika, is the ancestor of Ngāi Tara which creates our shared whakapapa, Ngai Tara o Mua Ūpoko o Te Ika o Maui. The half-brother of Tara-Ika was Tautoki, the father of our whanaunga Rangitāne.

Muaūpoko is translated to mean 'head of the fish' or 'people of the head of the fish,'; the fish being Te Ika a Māui, the North Island of New Zealand. The fish's head is the bottom of the North Island, where Muaūpoko are born of the land. According to some, Muaūpoko are descended from tangata whenua who lived on the land preceding waka arrivals from the Pacific, referred to as Mua-o-te-tangata or Muatetangata. But for most, Muaūpoko story of origin began with the arrival of Kupe from Hawaiki on the Matahourua waka, or more recently, the migration of Whātonga on the Kurahaupo waka.

Some Muaūpoko believe the Tararua Range was named after Hotuwaipara and Reretua- the two wives of Whātonga and mothers of Tara-Ika and Tautoki, respectively. Others claim the range was named after Tara-Ika himself, who had already been memorialized in some features of the land where he established his people, for example, Te Whanganui-a-Tara and Te

Waewae Kapiti o Tara rāua ko Tautoki. Kapiti Island was named by Whātonga for his two sons as a signpost for their travels and shared territory.

Our mana lives on in our traditional rohe through the names of places and through the connections of our people, stories handed down through our generations. In the following sections, we outline our mātauranga and values that describe our mana within our landscape.

Haunui-a-nanaia is our ancestor from the Aotea waka, he travelled through our region naming waterways and places along his journey. His journey for us represents discovery of the area whereby the Ohau River was named O-Hau from “of Haunui”. Our ancestor, Te Rangitakoru sung a nursery rhyme for his daughter Wharaurangi featuring our ancestor’s discovery and naming of our awa Ohau (Figure 5).

Te Rangitakoru's nursery song for his daughter, for Wharaurangi	Ko te popo a Te Rangitakoru mo tana tamahine, mo Wharaurangi
O, my daughter when you came from afar, And your hands were formed, and your feet, And your face, you floated, O daughter, In the Kurahaupo, Ruatea's canoe, When you embarked in the Aotea, the canoe of Turi, You forded the whenua kura at its mouth Thence was made the house of Rangitawi. Let us plant the kumara, And sow the karaka, in the land bordering the sea. Sink deep the post, Leave it for Ngā tuahine, from Nonoko-uri, From Nonoko-tea, the Hererunga and Korohunga. Hau took up some sand in the palm of his hand, and his staff. When he crossed over the river, Finding it was wide he called it Wanga-nui; Splash the water, which will reach Wangae-hu. The length of a fallen tree, is Tura-kina Having many times lifted up his feet, Tikei. When his heart sank within him, Manawatu. When the wind whistled past his ears, Hokio. **The small river he called, Ohau**. When he carried his staff in a horizontal position, Otaki. When he prayed, O daughter, it was Wai-mea. When he looked out of the corner of his eye, Wai-kanai. When he became weary, my daughter, he reached Wai-raka. He repeated an incantation, She became fixed above, and fixed below, And she remained immovable. My daughter, when his eyes glistened with delight, He called the place Wai-rarapa, It was the rejoicing of your ancestors, my daughter. The sky became cloudless, On account of Waitiri's good will, She then enticed Kaitangata out to sea: She placed the plank across, And drove in a post to hold on by, called Meremere. She left to her offspring, Punga, the anchor of his canoe, As his name, Awhema. Enough, it is finished, O my daughter	*E hine aku, ki to kunenga mai I tawiti,* *Ki te whakaringaringa, ki te wha-kawaewae,* *Te wakakanohi-tanga, ka manu, e hine, te waka I a Ruatea,* *Ko Kurahaupo, ka iri mai taua, I runga I Aotea ko te waka ia Turi,* *Kau mai taua te ngutu whenua kura,* *Hanga iho te whare Rangitawi;* *Tiria mai te kumara,* *Ka ruia mai te karaka ki te taiao nei;* *Karia iho te pou tamawahinei,* *Ka waiho I Nga tua hine, I a Nonoko-uri,* *I a Nonoko-tea, ko te Hererunga, ko te Korohunga.* *Kapua mai e Hau ko te one ki te ringa,* *Ko te tokotoko. Ka witi I te awa,* *Ka nui ia, ko Whanga-nui;* *Tiehutia te wai, ko Wangae-hu;* *Ka hinga te rākau, ko Turakina;* *Tikeitia te waewae, ko Tikei;* *Ka tatu, e hine, ko Manawatu;* *Ka rorohio nga taringa, ko Hokio;* ***Waiho te awa iti hei ingoa mona ki Ohau.*** *Takina te tokotoko, ko Otaki;* *Kamehameha, ehine, ko Wai-mea;* *Ka ngahae nga pi, ko Wai-kanae;* *Ka tangi ko to mapu, e hine,* *Ka kite koe I a Wai-raka:* *Matapoutia; poua ki runga, poua ki raro,* *Ka rarau, e hine. Ka rarapa nga kanohi,* *Ko Wai-rarapa—te rarapatanga o to tupuna,* *E hine—ka moiki te ao ,* *Ko te pai a Waitiri;* *Kumea kia warea Kaitangata* *Ki waho ki te moana:* *Hanga te paepae, poua iho, te pou* *Whakamaro te rangi, ko Meremere:* *Waiho te Whanau, ko te punga* *O tona waka ko te Awhema.* *Kati, ka waka mutu, e hine.*

Figure 5: Te Rangitakoru nursery song for his daughter Wharaurangi

Wāhi tapu, taonga and tupuna are intrinsic parts of whakapapa, they are imprints of our people of the land. Wāhi tapu are sacred places and natural features important to us in the traditional, spiritual, ritualistic and mythological sense; wāhi taonga are places that our taonga species rely on for all or part of their life cycles. They are places our taonga breed, nest, forage for food and

retreat for safety. They are places where we gather kai, water and resources; and wāhi tupuna are places where our ancestors are connected, where they lived and passed, and where significant events occurred and shaped parts of their everyday lives.

We maintain the knowledge and relationship with hundreds of wāhi tapu across the Horowhenua and our wider traditional landscape. They are highly interconnected features generating connection to the whenua, wai and moana. These wāhi support our position as mana whenua, manifesting a link between the past and present, our ancestors and the surrounding environment. Wāhi tapu, wāhi tupuna and wāhi taonga are an imprint of our people and our mātauranga on the whenua, both past and present. They include our:

- urupā (burial grounds)
- places where our ancestors lived and experienced their lives
- locations where significant events once occurred and still occur today
- travelling tracks and key transport routes
- natural resource collecting areas, both past and present
- cultivation clearings and food producing soils
- ritualistic areas
- temporary and permanent settlements
- fortified pā sites
- entry to the realms of kaitiaki and taniwha
- places where our taonga species thrive
- mountains and mountain peaks
- rivers, wetlands, lakes and forest areas.

The following sections describe our wāhi and values within each cultural landscape that the storage reservoir project lies.

The following features are associated with our mātauranga of the Ōhau landscape:

- Make kia was a place the floodwaters of the Ōhau Awa would connect to the Waiopehu area. Our ancestors would go to this place after the floods to plant new trees for harvesting because the land would become rich and fertile. In particular, our ancestor Noa te Whata would undertake this activity.

- Mā keokeo are viewpoints of small peaks along the Tararua Range that would be used as a gauge when travelling.

- Puke tiwai/tawai is a lookout point, covered in tawai trees. This view is a monitoring point for our people.

- Te Karu o te Whenua or “the eye of the land” is a high point in the Ōhau River Reserve, surrounded by puna and the Ōhau River. There are big trees and places to climb where we can see over the land. It also is a point where tracks diverge into the ridges and hills.

- Kuha ti munga refers to the terrace above the Ōhau River and the flow of water through the terrace and gravels. Ferns and palms grow on the cliff face of gravels and are markers of the aquifer.

The following features are associated with our cultural and spiritual practices in the Ōhau:

- Wa moana is our waterhole, a large area in Ōhau Awa where our people swim and collect kai upstream.

- Make Retu is our spiritual power centre, that connects our people, wairua and wai. It is a place for pou and is associated with repeating sounds of flapping bird wings.

- Toka roa is a large rocky pathway. Along the path was a flat rocky area that we used for camping before entering into the Tararua Range.

The following taonga are associated with our cultural and spiritual practices in the Ōhau:

- Ngārara and ngata (wainuia) are associated with the awa margins. They are indicators of a healthy environment.

- Tuna (both longfin and shortfin), banded kokopu, kōaro, shortjaw kokopu, torrentfish and pirahau (lamprey), along with various types of bullies can be found in the Ōhau. This diverse aquatic community is precious, as our landscape is highly modified. It is an indicator of a healthy mauri. Our people continue to undertake informal cultural harvests from our awa Ōhau.

- New Zealand and banded dotterel are known to nest in the gravel bed of our awa Ōhau. Our dotterel are an integral, characteristic part of the ecosystem that we value. Our ancestors would take the eggs; they are endangered now and under strict rāhui.

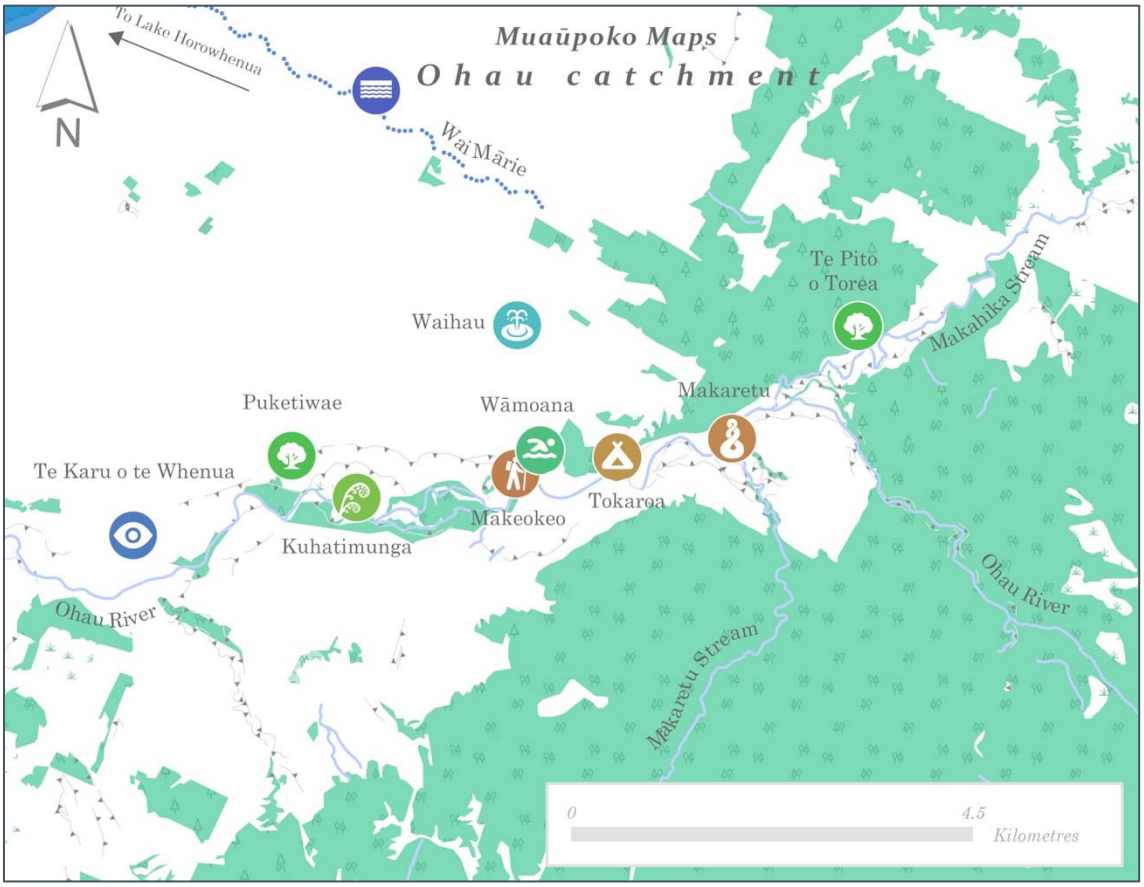


Figure 6: Ohau cultural landscape

Table 6: Values associated with our whakapapa.

Value	State	Class	Potential and actual effects
The discovery by our people and our names in the landscape.	Our ancestors named places throughout our traditional rohe describing significant events, people and landscape characteristics. Many names have endured and shape our world today, others are maintained within our mātauranga.	Very high	**Construction phase** *Risk of rewriting our narratives.* The potential reversible or irreversible adverse effect of the project overlooking, rewriting or belittling our traditional narrative and associated tikanga of our landscape during project inductions, site inductions, in project documentation and evidence generated as a result of applications for resource consent for the project. This has particularly high adverse implications for Muaūpoko given the pre-settlement status, previous changing of narrative through colonisation based on land acquisition goals and in a contemporary context from partnerships that enable core capacity building. **Operational phase** *Risk of rewriting our narratives.* The potential reversible or irreversible risk of the project overlooking, rewriting or belittling the traditional narrative of our landscape as people move through or about our rohe and undertake management decision making.
Accidental discovery of archaeological materials related to our ancestors.	Our ancestors are primarily buried in the sand dunes, however some were interred directly in their whare or at battle sites. Some of this knowledge has been lost and there remains a risk that we may encounter our ancestors and taonga within the project site.	High	**Construction phase** *Disturbing our ancestors' resting places* The potential irreversible effect of uncovering and disturbing the burial place of our ancestors. Others overriding our responsibilities to our ancestors – There is a risk others will attempt to override our tikanga and kawa when managing accidental finds that are dated after the 1820s, including kōiwi and taonga. While the risk of finds are very low if it does happen and is managed inappropriately the effects are very high for our people.

Our terrestrial and aquatic taonga – ngārara and ngata, ika and manu;	Neither our ngārara nor ngata have been found in the project area; however we know them to be present along the awa through our mātauranga. In addition, habitat potentially supporting ngārara and ngata is present on-site. The stretch of the Ohau has high-value instream aquatic habitats and the river morphology supports taonga species such as dotterel.	High	**Construction phase** *The accidental death of our ngārara, ngata, manu or ika and tune associated with Ohau.* The potential adverse effect of construction activities and earthworks in or adjacent to the Ohau Awa destroying a ngārara, ngata, manu or ika/tuna individual or disrupting breeding Disconnection of populations – the potential adverse effect of ngārara, ngata, ika/tuna or manu populations are prevented from interacting through the development of a construction zone in the riparian margins of the Ohau Awa. *The impact on our fish/taonga associated with Ohau.* The potential adverse effect of construction activities in Ohau Awa destroying fish, habitat and other taonga; increased impact on the ability for fish and invertebrate to migrate ki uta ki tai.

Table 7: Magnitude assessment – Our whakapapa.

Value	Activity / Effect	Magnitude WITHOUT management	Reasoning	Proposed effects management	Magnitude WITH management
Construction phase effects					
The discovery by our people and their naming in the landscape.	Risk of rewriting narratives. **Confidence**: Moderate **Scale**: Effects our identity through time **Duration**: The planning and construction phases of the project Reversible: Yes **Timing**: Ongoing issue	High	It is critical our narrative is communicated authentically through project documentation and reports, that our rights as mana whenua to manage our resources in a way that aligns with our mātauranga is acknowledged and described. Without this, we do not think our position as Treaty partners can be fulfilled.	Horowhenua District Council work with our people and provide adequate capacity to ensure project documentation and procedures are written in a way that is respectful and authentic, recognising our mana and mātauranga. Adequate capacity enables us to respond and provide input authentically and to participate in line with Treaty principles.	Positive
Accidental discovery of archaeological materials related to our ancestors.	Disturbing our ancestors resting places. Confidence: Low **Scale**: Local **Duration**: Permanent Reversible: No **Timing**: During major earthworks	Moderate	We will work with the project archaeologist to ensure all known places our ancestors lived, fought battles and were buried were avoided. Our people spent time across our landscape and there remains a small possibility that we may uncover kōiwi. The risk of disturbance is low however	An accidental discovery procedure is developed in partnership with our people including immediate cease works, communication with our iwi leaders and kaitiaki to ensure our tikanga is followed if such an event were to occur. We support scientific investigations that can confirm if the	Negligible

			effects would be very high if found and inappropriately managed.	archaeological material was deposited prior to the 1820s and thus belongs to our people. There will be a separate and specific requirement in regards kōiwi tangata discovery and a pre-agreed protocol for treatment of taonga.	
Our terrestrial and aquatic taonga – ngārara and ngata, ika and manu;	**Confidence**: Low **Scale**: Local **Duration**: Months as the find is managed **Reversible**: Potentially **Timing**: During earthworks and beyond	Moderate	Accidental deaths of taonga species can still occur in large infrastructure projects despite best management practice	Appropriate pre-construction surveys take place, defishing for all individuals and works do not occur in sensitive seasons for taonga species	negligible
Operational phase effects					
The discovery by our people and their naming in the landscape.	Risk of rewriting narratives. **Confidence:** Low **Scale**: Effects our identity long-term **Duration**: The ongoing operation of the highway **Reversible**: Yes **Timing**: Ongoing	High	The significant structures and operations required for the water take should recognise the key aspects of the cultural landscape they impact. If water is taken from our awa without appropriate recognition, then a precedent will be set that there is no marker of cultural significance. Our	A mahi toi plan that integrates with the Te Araroa Trail that identifies *at a minimum* how our Muaūpoko narrative and cultural connections including the naming of Ohau by our ancestors, its significance as our spiritual powerhouse (Make Retu), high values of mahinga kai,	Positive

		landscape markers must be uplifted and identified to ensure our culture and traditions are provided for as the water take impacts our landscape, our wai and disrupts our cultural connections.	wai māori (pure water) values is developed and delivered.	

4.3 Mana whakahaere

The principle of mana whakahaere considers how the relationship between our iwi, the project and the environment manifests. Mana whakahaere encompasses our right to govern, manage and participate in the project, especially when it comes to planning for our relationships with our wai. It includes creating hapū and iwi roles of decision making, not only consultation and engagement but also participation, management, and governance. This may be a difficult process, as sharing power has never been easy in the dynamics of central government; our past experiences have shown us this. The focus should be on ensuring that where there are decisions to be made, at all layers of the management system, our people are fairly represented. As the project takes shape, this means kaitiaki are integrated into construction teams on the ground and management roles, and our leaders into governance structures. Space and support should be made for this to occur.

Table 8: Values associated with our mana whakahaere.

Value	State	Class	Potential and actual effects
Mana whakahaere.	We have built a small ki uta ki tai kaitiaki team due to our recognition for the imperative for involvement in projects of this significance. Our highly constrained pre-settlement state, alongside historic exclusion and preclusion from both local government and wider Crown participation, has prevented the incremental development of core capacity. The MTA now has some environmental management capability to support Muaūpoko interests and landowners. MTA governance structures in place and can engage with the project. Our capacity remains in deficit and we require further support to participate at a core level as well as to take our organizations into the future.	Very high	**Construction phase** *Excluding our people from decision-making in the project*. The potential reversible adverse effect of HDC not recognizing and giving effect to our status as Treaty partners, our rights and responsibilities to make decisions, both high-level and day-to-day, over our lands and waterways in accordance with our tikanga. **Operational phase** *Excluding our people from decision-making in the ongoing operation and maintenance of the reservoir and water intake*. The potential reversible adverse effect of HDC not recognising and giving effect to our status as treaty partners, our rights, and responsibilities to make decisions, both high-level and day-to-day, over our lands and waterways in accordance with our tikanga.

Table 9: Magnitude assessment – Mana whakahaere.

Value	Activity / Effect	Magnitude WITHOUT management	Reasoning	Proposed effects management	Magnitude WITH management
Construction phase effects					
Mana whakahaere.	Exclusion of our people from decision making in the project. **Confidence**: Moderate, based on experience **Scale**: Effects our identity as an iwi through time **Duration**: The planning and construction phases of the project **Reversible:** Yes **Timing**: Ongoing	High	Access to specialists and expertise, including earthworks companies is critical to the delivery of the project. However, there remains a risk that a contractor does not value or understand what shared decision-making looks like. Business as usual is no longer adequate – mana whakahaere, the right to govern, manage and participate as we see appropriate, is now embedded in legislation, particularly in relation to freshwater management. HDC and HRC have a responsibility to enable our participation.	The mana of our iwi must be recognised in its own right and according to our values and aspirations. The proposed mana whenua representative group will need to recognise our mana whakahaere and reflect Muaūpoko engagement structure and leadership role as past owners of the whenua for hundreds of years. This is necessary due to past processes of exclusion of our people. The roles and responsibilities of the members of the group need to be defined through the RMA process. Our roles should be specific to our people, our values and aspirations as leaders in tikanga in this area.	Positive

Operational phase effects					
Mana whakahaere.	Excluding our people from decision making **Confidence**: Low **Scale**: Effects our identity long-term **Duration**: The ongoing operation of the highway Reversible: Yes **Timing**: Ongoing	High	Our decision-making role could easily fall aside after the project has been delivered, however our people and landowners (LHT) will live with the water take and associated structures forevermore. Our role as decision-makers is even more critical in the long-term in order for us to address any effects that were unforeseen or need adaptive management. This could include management of the ecological areas, water-quality/quantity effects or inappropriate access issues.	Throughout the project, we aim to continue to build our capacity to participate in the management of the project environment. The mana whenua representative group should effectively provide for active participation during the construction phase, and should then be moved into participation in ongoing operational management. The group would convene at regular intervals to assess the water demand management plan performance, the health of the Ohau Awa, its associated ecosystems, and any other business that may arise. The membership of the group must be specified. Both iwi should have the opportunity to undertake their own cultural health monitoring.	Positive

5 Level of effects assessment

It is important for HDC to understand the tino rangatiratanga, or sovereignty, and heightened values we hold over the Horowhenua block. This distinguishing factor, including the local place-based nature of our values, should guide decision makers in recognising the mana of whenua and wai, our people have with the upper Ohau area.

Alongside Muaūpoko pre-settlement status, this impacts our ability to build capacity and has created a perfect storm – we are now extraordinarily reliant on a few individuals to participate, protect and partner for Muaūpoko interests, lands, waterways and taonga, and perform our role as kaitiaki and tangata whenua decision makers.

We have worked hard to address these effects and minimise them to the greatest practicable extent. These levels of effects are summarised in Figure 7. Going forward, our needs centre on the Treaty principles of partnership and participation, and continued protection and enhancement as the Taitoko drinking water scheme project develops.

Value	Activity / Effect	Cultural value	Magnitude WITH management	Overall effect
Our worldview				
Growth and knowledge during construction.	Inability to pursue our growth and knowledge as an iwi in the construction phase.	Very high	Positive	Net Gain
Connections with and between our atua during construction	Disrupts the relationships between atua, kaitiaki and the environment in the construction phase.	Very high	Negligible	Low
Growth and knowledge during operation.	The inability to pursue our growth and knowledge as an iwi in the operational phase due to capacity constraints.	Very high	Positive	Net Gain
Connections with and between our atua during operation	Disrupts the relationships between atua, kaitiaki and the environment in the operational phase.	Very high	Low	Moderate
Our whakapapa				
The discovery by our people and their naming in the landscape during construction	Risk of rewriting narratives during construction.	Very high	Positive	Net Gain
The discovery by our people and their naming in the landscape during operation	Severing connections ki uta ki tai during construction.	Very High	Positive	Net gain
Accidental discovery of archaeological materials related to our ancestors during construction.	Disturbing our ancestors' resting places during construction.	High	Negligible	Very Low
Impacts on our terrestrial and aquatic taonga – ngārara and ngata, ika and manu;	The accidental death of our ngārara, ngata, manu or ika and tune associated with Ohau	High	Negligible	Very Low

Te Mana o te Wai

Mana whakahaere.	Exclusion of our people from decision-making in the project during construction and operational phases.	Very high	Positive	Net gain

Figure 7: summary of effects

6 Conclusions

This CIA addresses the impacts of preliminary activities to prepare for a new water storage reservoir on the values of Muaūpoko (Ngai Tara ki Mua Ūpoko o te Ika a Maui). The CIA will inform a resource consent to increase the water take from the Ohau Awa and construct an inlet and pipe bridge. Further resource consent will be sought to permit the construction of the reservoir and a Notice of Requirement will be submitted to designate the site. The reservoir will supply Taitoko and surrounding communities with drinking water. The reservoir is required to meet the growing demand for water and to improve the resilience of the Taitoko water supply.

The Ohau Awa is approaching its sustainable allocation limits and there is impact on habitat values in takes below low flow which has implications for the health and wellbeing of Muaūpoko alongside the awa. The Ohau Awa is hydraulically connected to groundwater and Punahau/Lake Horowhenua, with several small springs visible alongside the reservoir site. The project will affect the mauri of the Ohau Awa and those water bodies it is hydraulically connected to. Muaūpoko have lived on the land for 1,000 years. We are tangata whenua. The Horowhenua block including the project area is our contemporary heartland and we maintain traditional connections to the Ohau landscape and beyond. Although the mauri of our awa will be affected by the construction and ongoing operation of the proposed reservoir, there is the opportunity to offset the impact by enhancing the role of Muaūpoko as kaitiaki and the ecological health of the awa.

Offsetting the adverse impact of the project on Muaūpoko values would involve uplifting our position and role as tangata whenua in the Horowhenua and wider landscape as part of the drinking water scheme project. We would be supported to have the capacity and capability to fully participate as a Tiriti partner. This means being empowered to manage our whenua, wai and significant sites in line with our tikanga. In this CIA, we have identified how we wish this to be undertaken, how our values of kaitiakitanga, manaakitanga and mana whakahaere are critical to our success in protecting our interests. We would like to lead the development of a riparian and floodplain restoration plan and its implementation as a way of uplifting Te Mana o te Wai, our rights and responsibilities to manage the Horowhenua Block.

We will continue to work alongside HDC to ensure we deliver the best outcomes for our people, te taiao and the wider Taitoko community in a way that is responsive to our worldview and our whakapapa. Most critically, HDC must respect the way in which we are able to engage because of historic Treaty breaches, exclusion and marginalisation of our people.

We have genuinely applied and held ourselves accountable to the collective vision of the scheme and we will continue to do so.

7 Recommendations

We reccomend the following condition is adopted by the project and other effects management procedures are integrated into the conditions set more broadly. We will work with HDC to undertake this exercise.

Cultural Offsetting Management Plan	
1.	The consent holder shall invite Muaūpoko to prepare the Cultural Offsetting Management Plan.
2.	The objective of the Cultural Offsetting Management Plan is to demonstrate how no net loss, and preferably a net gain, of mauri in the Ohau Awa and habitat availability are achieved through the implementation of offset activities
3.	The Cultural Offsetting Management Plan shall include: a. Identification of an appropriately qualified person, approved by Muaūpoko to oversee the Cultural Offsetting and the person's role and responsibilities. b. The process for selecting the site(s) c. A summary of the cultural values at the impacted site and offset site d. A monitoring framework that can measure the identified cultural values including mauri and habitat availability e. A summary of approaches needed to enhance mauri and habitat availability at the offset site to achieve a no net loss and preferably a net gain f. A description of the program of actions required to achieve the offset g. A description of the offset principles and how the offset will achieve the principles to guide the development of the cultural effects offset proposal
4.	The consent holder shall adopt Cultural Offsetting Management Plan and once adopted provide the Plan to The Manager for certification that the Cultural Offsetting Management Plan contains the matters set out below
Cultural Offsetting Monitoring	
5.	Once an offset site is secured a baseline assessment shall be undertaken of the site in accordance with the Cultural Offsetting Management Plan monitoring framework
6.	In the third and fifth years following the completion of the cultural offsetting works monitoring in accordance with the Cultural Offsetting Management Plan monitoring framework shall be undertaken
7.	In the eighth year following the completion of the cultural offsetting works, the offsetting measures shall be reviewed to ensure no net loss has been achieved. The review shall include: a. A summary of progress towards achieving a no net loss and preferably net gain of mauri and an assessment of progress in achieving the restoration objectives b. Confirmation of whether a no net loss or net gain of mauri have been achieved or are expected to be achieved. c. If required recommended additional measures to be implemented to achieve no net loss or net gain of mauri. d. If a no net loss has not been achieved or is not expected to be achieved the Cultural Offsetting Management Plan shall be reviewed and new actions included to achieve no net loss or net gain of mauri. The updated Cultural Offsetting Management Plan shall be provided to The Manager.
8.	The Cultural Offsetting Monitoring shall be undertaken by an appropriately qualified person, approved by Muaūpoko

We also recommend the development of an adaptive management strategy with the following parameters

Adaptive Management Strategy	
9.	The consent holder shall, with oversight from the mana whenua rōpū, established under condition XX, prepare and implement an Adaptive Management Strategy for the Taitoko Drinking Water

	Scheme. The Adaptive Management Strategy shall be reviewed and updated on a three yearly basis.
10.	The Adaptive Management Strategy shall be developed and implemented to achieve the following Adaptive Management Objectives: a. The amount of treated drinking water lost to leakage from Taitoko will be reduced over the term of the resource consent. b. Existing and new households will be supported to invest in and construct stormwater tanks over the life of the consent. c. Beneficial uses for treated wastewater will be identified, investigated, and where proven feasible adopted to minimise freshwater take. d. Sustainable outcomes for resource management including minimising energy use must be achieved. e. Freshwater takes during low flow will be minimised through ongoing review and implementation of best management practice. f. The effects of the drinking water take will not grow over time in response to urban growth as a result of the Adaptive Management Strategy

Appendix A: Location plan

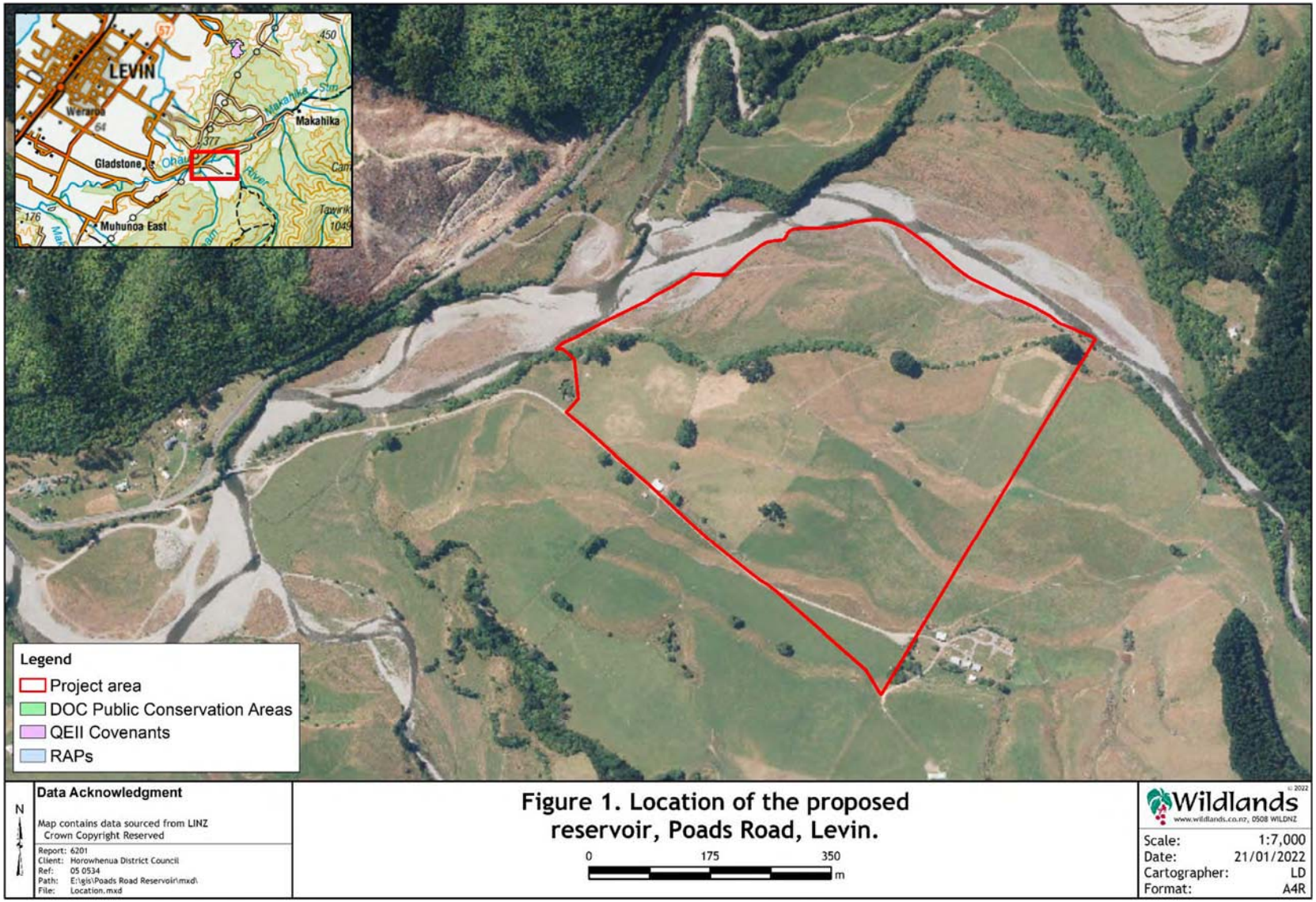


Figure 1. Location of the proposed reservoir, Poads Road, Levin.

Disclaimer

We have used various sources of information to write this report. Where possible, we tried to make sure that all third-party information was accurate. However, it's not possible to audit all external reports, websites, people, or organisations. If the information we used turns out to be wrong, we can't accept any responsibility or liability for that. If we find there was information available when we wrote our report that would have altered its conclusions, we may update our report. However, we are not required to do so.

This report provides an overview assessment and has not provided details where those are not currently considered to be relevant to the Taitoko drinking water scheme. Muaūpoko reserve the right to update this report through the upcoming RMA process.

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VERSION	DATE	AUTHORS	COMMENTS
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3	31/05/23	Dean Wilson (MTA Environmental Manager, Lake Horowhenua Trustee, iwi leader)	
4	02/06/23	Di Rump (MTA CEO, iwi leader, MMIL)	

Appendix G

ECOLOGICAL ASSESSMENT - RIVER INTAKE

ECOLOGICAL ASSESSMENT OF A PROPOSED INTAKE STRUCTURE FOR THE POADS ROAD RESERVOIR, LEVIN



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R6201e

ECOLOGICAL ASSESSMENT OF A PROPOSED INTAKE STRUCTURE FOR THE POADS ROAD RESERVOIR, LEVIN

Contract Report No. 6201e

January 2023

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1. INTRODUCTION

Horowhenua District Council is planning to construct a new water reservoir at Lots 9, 10, and 11 between Poads Road and the Ohau River, on a river terrace approximately six kilometres southeast of Levin (Figure 1). Water is to be supplied to the reservoir via a new intake structure to be constructed beneath the channel of the Ohau River.

Good Earth Matters commissioned Wildland Consultants, on behalf of Horowhenua District Council, to provide a high-level assessment of the potential ecological impacts associated with constructing the intake structure within the Ohau River, as well as the infrastructure required to transport the water to the actual reservoir.

2. METHODS

A site visit was undertaken with Annette Sweeney of Good Earth Matters and Daniel Bardsley of Damwatch Ltd on 8 November 2022 to inspect the location proposed for the intake structure and carry out a high-level ecological assessment to determine the potential effects of the construction works and ways in which these can be avoided or mitigated.

The site visit involved a walkover of the proposed reservoir site and the section of the Ohau River where the intake structure is to be constructed. A detailed assessment of vegetation, flora, and fauna present within this area was outside the scope of this report, which is intended to provide a high-level overview of the habitats that will be modified by the proposed works. Potential hydrological effects related to the extraction of water from the Ohau River was also outside the scope of this assessment.

3. PROPOSED INTAKE STRUCTURE AND RESERVOIR SPILLWAY

3.1 Background

The proposed layout of the reservoir, intake structure, pipelines, and emergency spillway referred to below is shown on the plan in Appendix 1.

The following project components are discussed further below:

- Intake structure and sumps.
- Reservoir spillway.
- Vehicle access.
- Temporary diversion channel.

3.2 Intake structure and sumps

The proposed intake structure will take water from the Ohau River and pump it to the reservoir via a pair of sedimentation sumps and pump sumps that will be constructed on the true left bank of the river. For each of these paired structures, the sedimentation



Figure 1: Location of proposed reservoir and intake structure, Poads Road, Levin

sump will allow suspended sediment to settle out of the water before it flows into a secondary sump that contains a large submersible pump that will supply the water to the reservoir via a pipeline.

The proposed intake structure is an infiltration sump design, where several perforated pipes will be laid within gabion baskets filled with highly permeable gravel and installed across the full width of the Ohau River channel and around 1.5 metres below the level of the riverbed (see Appendix 2). Water will then percolate down into these pipes and be pumped into the sedimentation and pump sumps that will be connected to the pipelines supplying the reservoir. A network of diffuser pipes will also be installed within the gabion baskets and will be used to periodically backwash accumulated sediment from the gravel matrix using a mixture of compressed air and water.

The entire intake structure within the river channel will be made up of four identical infiltration sections, which will be 27 metres wide and combined a total length of 89.5 metres.

The true left bank of the river will also be modified along the entire length of the intake structure, with the riparian vegetation to be removed from this area and the steep slope will be reinforced with a 400 millimetre-deep layer of rock rip-rap to prevent erosion.

3.3 Reservoir spillway

An emergency spillway for the reservoir will also be constructed to the west and downstream of the intake structure and pipelines. This spillway will consist of a large constructed channel that will only become operational if the reservoir is over-capacity, in which case the flow down the spillway and into the Ohau River will ensure that the structural integrity of the reservoir is maintained.

3.4 Vehicle access

The infiltration sump layout plan provided in Appendix 2 also shows the indicative location of an access road for maintenance of the intake structure and associated equipment. While the full length of this access road is not shown, it appears that it will run partway along the bank of the river immediately above the infiltration sump.

3.5 Temporary diversion channel

Before the intake structure can be installed within the riverbed a diversion channel will be constructed on the true right bank to divert all flow around the works site. This will enable the works to be undertaken with a minimum of disturbance to the downstream environment.

The exact size and location of the diversion channel is yet to be determined, although an indicative location for it is provided in Figure 1. Likewise, the methods by which the river will be blocked and flow will be diverted into the channel are still to be determined.

4. ECOLOGICAL ASSESSMENT

4.1 Overview

While a detailed ecological assessment of the proposed intake site was out of scope during the site visit, some general conclusions regarding the quality of the habitats present were able to be made on the following parts of the site:

- Impact reach within the Ohau River.
- Riparian vegetation.

4.2 Impact reach within Ohau River

The *c.*100 metre reach of the Ohau River that will be directly impacted by the construction of the infiltration sump consists of a wide, relatively shallow run section grading into a section of riffle at the downstream end (Plates 1 and 2).

This section of river provides high-quality habitat for indigenous fish and macroinvertebrates, with riffles being a particularly productive habitat type within large river systems. Its position within the wider catchment means that it is also critical to maintain connectivity through this area, to allow the natural migration and movement of fish and macroinvertebrates in both upstream and downstream directions.



Plate 1: Proposed location of the infiltration gallery, looking upstream. The rock in the background near the true right bank provides a rough indication of where the upstream extent of the structure will be located. 8 November 2022.



Plate 2: Proposed location of infiltration gallery, looking downstream. The upper run section grades into a longer riffle section in this area. 8 November 2022.

4.3 Riparian vegetation

The section of the true left bank along which the erosion protection armouring will be installed (see Appendix 2) is steep and covered in dense tutu (*Coriaria arborea* var. *arborea*), with occasional clumps of toetoe (*Austroderia fulvida*) (Plate 3). Exotic pampas grass (*Cortaderia selloana*) is also present along the river margins. The understorey is a mixture of indigenous species including *Coprosma* spp., māhoe (*Melicytus ramiflorus*), and wheki (*Dicksonia squarrosa*) (Plate 4).

No rare or threatened indigenous vegetation was observed during the site visit, with all indigenous species being widespread and common. Vegetation in the proposed impact area is therefore of moderate ecological value.

5. POTENTIAL ECOLOGICAL EFFECTS

5.1 Overview

Construction and operation of the proposed intake structure will have a range of direct and indirect impacts on the Ohau River and its riparian margins, some of which will be temporary but others will be long-term or permanent.

Temporary impacts will primarily occur during the construction phase of the project. These will include the diversion of the river flow, extensive excavation of the riverbed, and disturbance during the construction works along the true left riverbank.



Plate 3: Dense tutu cover on the true left bank of the Ohau River in the vicinity of the proposed intake structure. 8 November 2022.



Plate 4: Dense indigenous understorey along the true left riverbank. 8 November 2022.

Long-term and permanent impacts will be those that are associated with the continuing operation of the intake structure, such as the extraction of water from the river system, maintenance of the subsurface infiltration gallery, and permanent structures along the true left riverbank.

Potential effects associated with each stage of the proposed works are addressed in the sections below:

- Excavation of riverbed and diversion of river flow.
- Construction of bank armouring.
- Construction of emergency spillway, access road, and intake infrastructure.
- Sedimentation and habitat disturbance during routine maintenance.

5.2 Excavation of riverbed and diversion of river flow

Extensive excavation of the riverbed using heavy machinery will be required to install the infiltration gallery. Before this work can be undertaken within the river a temporary diversion channel will need to be excavated along the true right bank and a diversion structure is to be installed at the upstream extent of the works area, to direct all flow into the new channel.

The use of heavy machinery in and around the Ohau River has the potential to liberate large volumes of sediment during the excavation of the riverbed and banks, as well as causing large-scale disturbance of the in-stream habitat and potential mortality of indigenous fish species.

Diversion of flow around the impact reach will also temporarily eliminate all aquatic habitat for indigenous fish and invertebrates in this area.

5.3 Construction of bank armouring

Construction of the bank armouring along the true left bank of the river adjacent to the infiltration gallery will require the complete removal of all riparian vegetation within this area, to be replaced with a layer of rock rip-rap. This will therefore mean that the removal of the riparian vegetation will be permanent, with this area remaining unvegetated once the intake structure has been completed.

Because this work will be undertaken immediately adjacent to the river channel there is a high risk of sediment discharges occurring if appropriate control measures are not implemented.

5.4 Construction of emergency spillway, access road, and intake infrastructure

Construction of the emergency spillway, access road, and intake infrastructure (notably the pipelines to the reservoir) will also require extensive earthworks and the removal of some riparian vegetation on the true left bank of the river. However, most of the areas to be cleared for these works will be open farmland covered with pasture grasses, so the amount of riparian vegetation to be removed will be less than what is required for the bank armouring.

5.5 Sedimentation and habitat disturbance during routine maintenance

The infiltration gallery will be fitted with a series of backwash diffuser pipes located above the infiltration collector pipes within the gravel-filled gabion baskets (see Appendix 2). These backwash pipes will allow compressed air to be forced through the gravel to clear out any fine sediment that has settled there. This will be undertaken as part of routine maintenance, to ensure that the infiltration collector pipes do not become blocked.

The backwash system could potentially release sediment into the Ohau River and cause localised disturbance of resident fish populations during the periods when it is in operation.

6. MITIGATION OPTIONS

6.1 Overview

To address the potential impacts of the construction and operation of the intake structure and associated works, the following plans and actions are suggested to avoid and/or mitigate undesirable effects:

- Sediment control plan.
- Spill response plan.
- Fish management plan.
- Riparian planting.
- Environmental disturbance due to intake maintenance.

6.2 Sediment control plan

To prevent accidental sediment discharges from affecting the aquatic environment downstream, a comprehensive Sediment Control Plan will be required prior to undertaking any earthworks in the vicinity of the Ohau River. The work with the highest potential to result in sediment discharges will be construction of the diversion structure within the river and the excavation of the diversion channel, as well as the vegetation clearance and recontouring of the true left bank in preparation for the installation of the bank armouring.

A comprehensive sediment control plan will be required for this work, including specific measures to be undertaken to control sediment at source and prevent discharges into the active channel from occurring.

6.3 Spill response plan

Because heavy machinery will be required to work within the channel of the Ohau River there is a risk that fuel, lubricants, or other substances could be discharged accidentally into the watercourse. A Spill Response Plan should be prepared prior to work commencing to address this risk, and supplies of spill response equipment should also be stored on-site while this work is underway.

Wherever possible, excavators and other heavy machinery should operate outside of the river channel to reduce the amount of disturbance to the river environment, including compaction of the riverbed.

6.4 Fish management plan

Works within the bed of the Ohau River have the potential to kill and injure fish, so a Fish Management Plan (FMP) will be required to address and mitigate this effect. The FMP will need to outline the methodology by which the impact area within the channel will be isolated and the fish in this reach will be captured and relocated before the flow within the impact reach is diverted and excavation can begin.

The wadeable depth of the river within the impact reach indicates that intensive electric fishing is likely to be the most effective method to capture the resident fish in this area. Because of the size of the channel, it is likely that two teams, each with an electric fishing machine, will need to undertake multiple passes through this reach to capture and relocate all the fish present.

6.5 Riparian planting

Removal of riparian vegetation along the left bank of the Ohau River will have minimal ecological effects due to the vegetation being composed of common plant species and extensive amounts of similar habitat being present within the immediate area. Even though the effects of this vegetation removal will be minor, a riparian planting programme to replace some of the vegetation removed with suitable indigenous species should be implemented.

6.6 Environmental disturbance due to intake maintenance

Operation of the air backwash system for routine maintenance is unlikely to have anything other than a minor effect on the aquatic environment. Any disturbance to aquatic fauna will be temporary, and the discharge of sediment is likely to be similar to that which occurs during natural events.

7. CONCLUSION

While extensive earthworks and a large amount of riverbed excavation will be required to construct the proposed intake structure and its accompanying infrastructure, the ecological effects of this work can be managed effectively through careful planning, particularly in relation to sediment control and the capture and relocation of fish from within the impact reach.

Once constructed, the ongoing operation of the intake structure is expected to have minimal ecological effects due to the infiltration gallery being designed to be located below the level of the existing riverbed. Excavation of the riverbed to install the intake structure will result in some short-term disturbance to aquatic fauna in the area and will require extensive recontouring of the riverbed. However, once the diversion channel is decommissioned and flow resumes within the main river channel it is expected that the riverbed will return to its natural form due to bed movement during flood events.

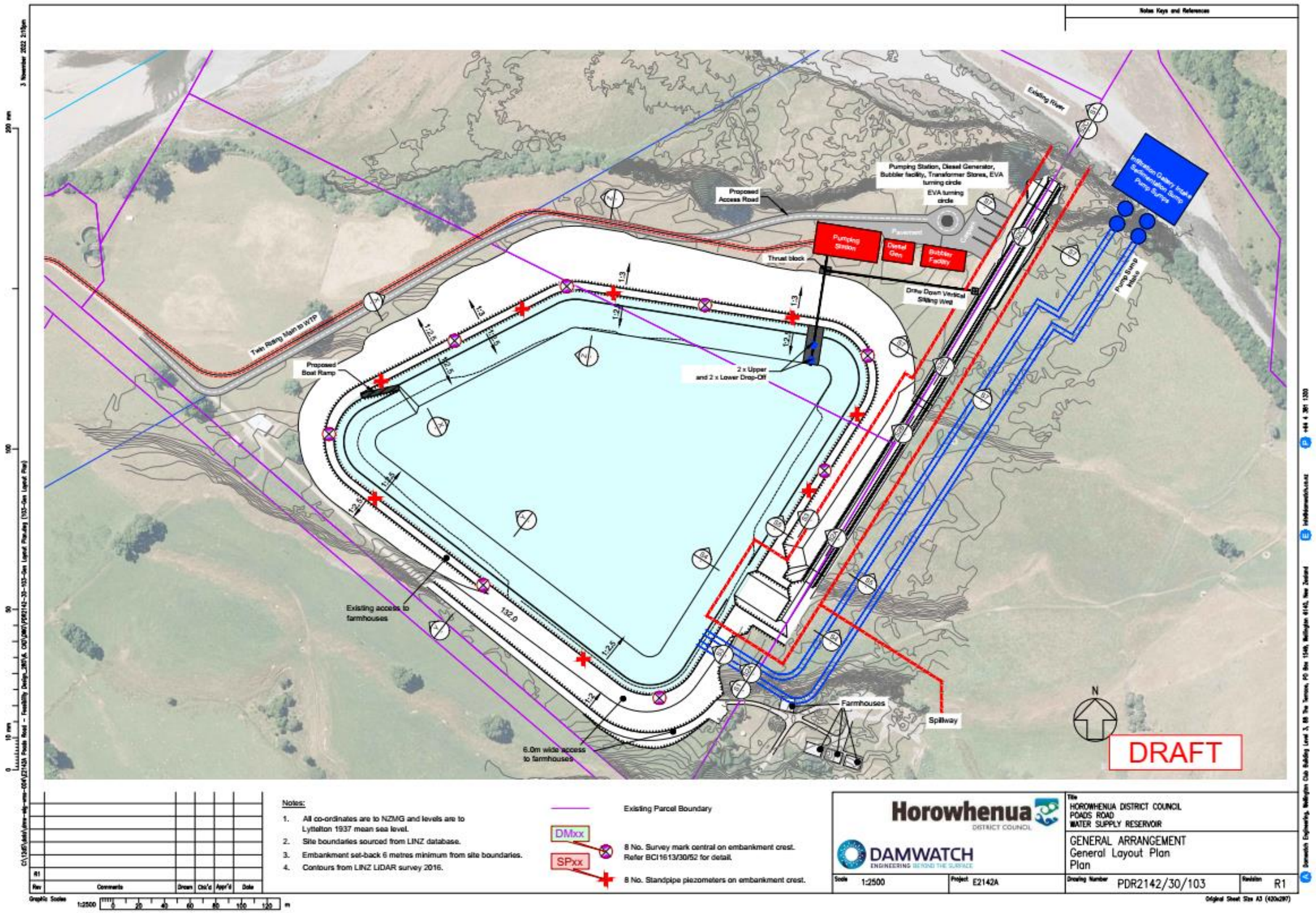
Overall, construction and operation of the proposed intake structure will have relatively minor ecological impacts on the Ohau River and its surrounding environment subject to appropriate mitigation measures being implemented.

ACKNOWLEDGMENTS

Annette Sweeney of Good Earth Matters provided access to the site and information on the proposed development. Daniel Bardsley of Damwatch Ltd assisted with the site visit and provided technical information on the proposed design of the reservoir intake infrastructure.

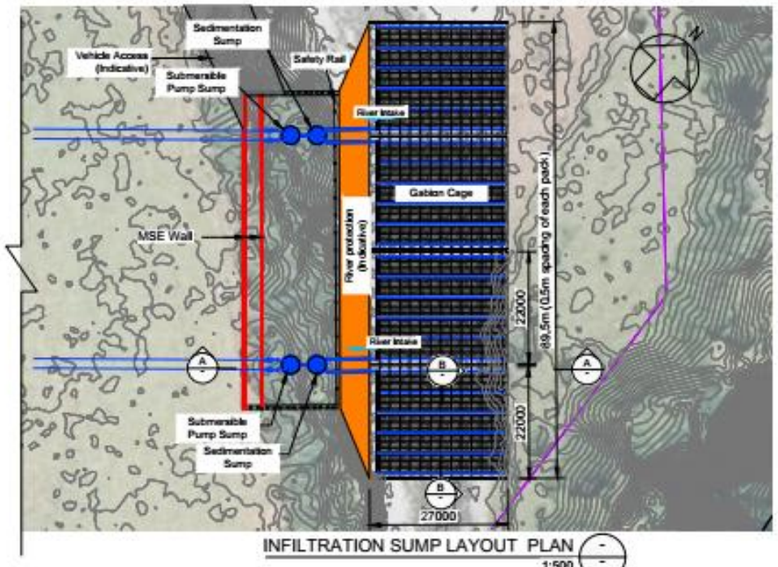
APPENDIX 1

PROPOSED SITE LAYOUT

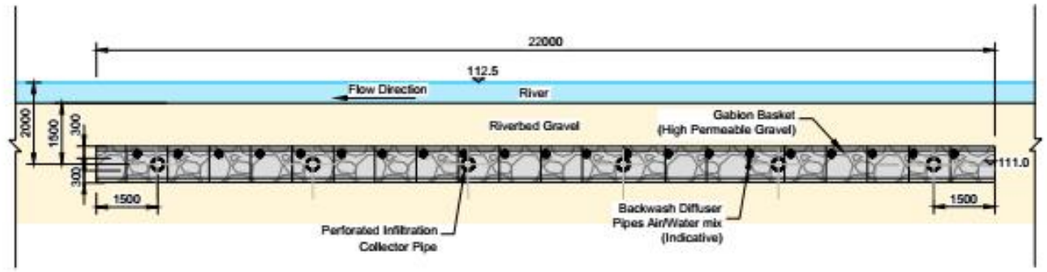

Notes Keys and References
Existing River
Proposed Access Road
Pumping Station, Diesel Generator, Bubbler facility, Transformer Stores, EVA turning circle
EVA turning circle
Pavement
Culvert
Pumping Station
Diesel Gen
Bubbler Facility
Thrust block
Drive Down Vertical Shifting Weir
Intake Gallery, Intake, Sedimentation Sump, Pump Sumps
Pump Sump Intake
Twin Rising Main to WTP
Proposed Boat Ramp
2 x Upper and 2 x Lower Drop-Off
Existing access to farmhouses
6.0m wide access to farmhouses
Farmhouses
Spillway
N
DRAFT
Notes:
1. All co-ordinates are to NZMG and levels are to Lyttelton 1937 mean sea level.
2. Site boundaries sourced from LINZ database.
3. Embankment set-back 6 metres minimum from site boundaries.
4. Contours from LINZ LIDAR survey 2016.
Existing Parcel Boundary
DMxx
8 No. Survey mark central on embankment crest. Refer BCI1613/30/52 for detail.
SPxx
8 No. Standpipe piezometers on embankment crest.
Horowhenua DISTRICT COUNCIL
DAMWATCH ENGINEERING BEYOND THE SURFACE
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR
GENERAL ARRANGEMENT
General Layout Plan
Plan
Scale 1:2500
Project E2142A
Drawing Number PDR2142/30/103
Revision R1
Original Sheet Size A3 (420x297)

APPENDIX 2

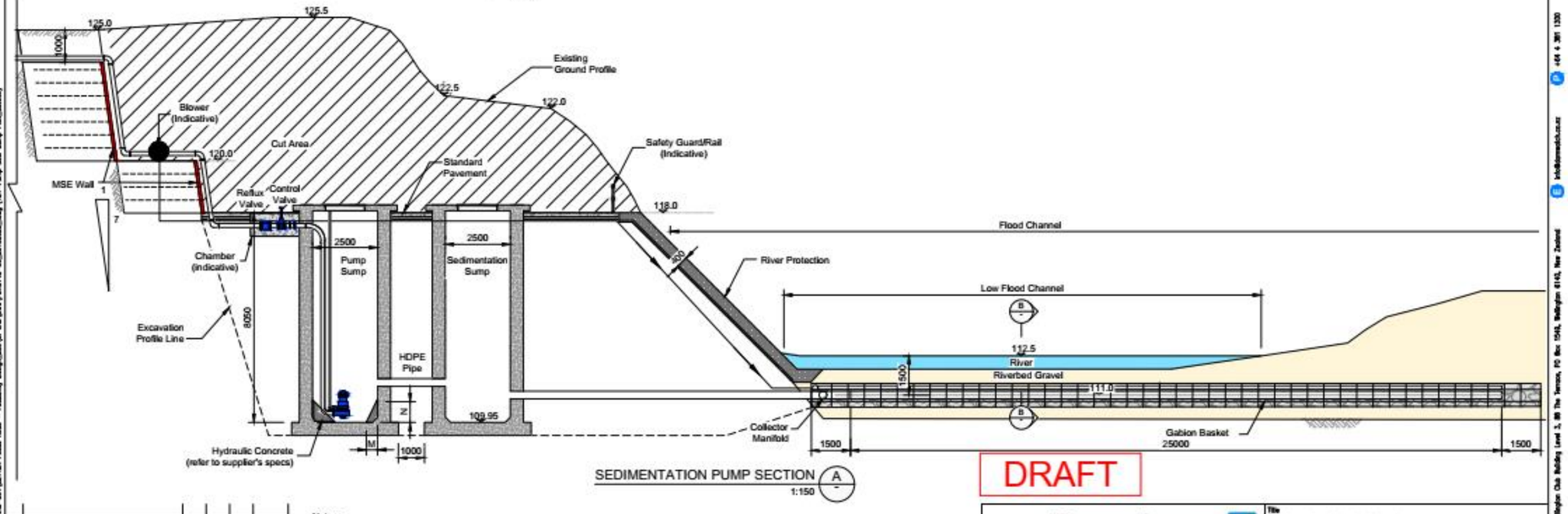
ENGINEERING DRAWINGS
OF PROPOSED INTAKE
INFRASTRUCTURE



INFILTRATION SUMP LAYOUT PLAN - 1:500



TYPICAL PEFORATED INFILTRATION SECTION B - 1:125



SEDIMENTATION PUMP SECTION A - 1:150

DRAFT

Notes:

1. All co-ordinates are to NZMG and levels are to Lyttelton 1937 mean sea level.
2. Site boundaries sourced from LINZ database.
3. Embankment set-back 6 metres minimum from site boundaries.
4. Contours from LINZ LiDAR survey 2016.

M = 431.88mm ; N = 889mm

Rev	Comments	Drawn	Ckd'd	Appr'd	Date
R1	Issue for Comment	FS	FZ	JE	

Graphic Scales

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title: HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

RIVER INFILTRATION GALLERY
Plan And Section of
Pump and Sedimentation Sump

Scale	Project	Drawing Number	Revision
AS SHOWN	E2142A	PDR2142/30/121	R1

Original Sheet Size A3 (420x297)



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ECOLOGY RESTORATION BIODIVERSITY SUSTAINABILITY

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Appendix H

ECOLOGICAL ASSESSMENT - RESERVOIR SITE

Wetland Delineation at Poads Road, Levin

Contract Report No. 6201c-2

Providing outstanding ecological services to sustain and improve our environments

Wildlands

Wetland Delineation at Poads Road, Levin

Contract Report No. 6201c-2

June 2024

Project Team:

Brent Henry – Site evaluation and report author

Prepared for:

Horowhenua District Council
Private Bag 4002
Levin 5540

Reviewed and approved for release by:



_____
26/07/2024
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Director/Lead Principal Ecologist
Wildland Consultants Ltd

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1.0 Introduction

Horowhenua District Council has identified the need to augment their current water supply and storage facilities for the Levin Water Treatment Plant. Good Earth Matters Consulting Ltd is preparing a resource consent application, on behalf of the District Council, to construct a new water reservoir and increase the currently consented water take from the Ohau River.

The project will involve the construction of a new water reservoir on Lot 9 DP555714 on a river terrace between Poads Road and the Ohau River, approximately six kilometres southeast of Levin (Figure 1). Water is to be provided to the reservoir from the Ohau River via a new intake structure. An outlet structure is also to be installed downstream. The currently consented rate of water extraction from Ohau River is 15,000 cubic metres (m^3/day). Damwatch (2020) indicates that additional water will need to be taken from the Ohau River to future-proof the water supply and to provide an acceptable filling rate for any proposed larger water storage reservoir to meet the demand of the expected population growth in Levin.

An initial site visit to identify ecological constraints within the proposed Poads Road Water Storage Reservoir was carried out in January 2022. The ecological constraints survey identified potential wetlands within the site, two of which were within the proposed reservoir footprint (Figure 1).

On behalf of Horowhenua District Council, Good Earth Matters Consulting Ltd asked Wildlands to undertake a wetland assessment and delineation of the areas identified in the previous constraints assessment.

2.0 Methods

The property was visited and surveyed on 2 November 2023, during which time the potential wetland habitats noted in the Wildlands constraints assessment, were described, assessed, and delineated as per the NPS-FM (see below).

The RMA defines a wetland as "*permanently or intermittently wet areas, shallow water, and land/water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions, including within the coastal marine area*".

The National Policy Statement for Freshwater Management (NPS-FM) defines a 'natural inland wetland' as:

Natural inland wetland *- a wetland (as defined in the Act) that is not:*

(a) in the coastal marine area; or

(b) a deliberately constructed wetland, other than a wetland constructed to offset impacts on, or to restore, an existing of former natural inland wetland; or

(c) a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body; or

(d) *a geothermal wetland; or*

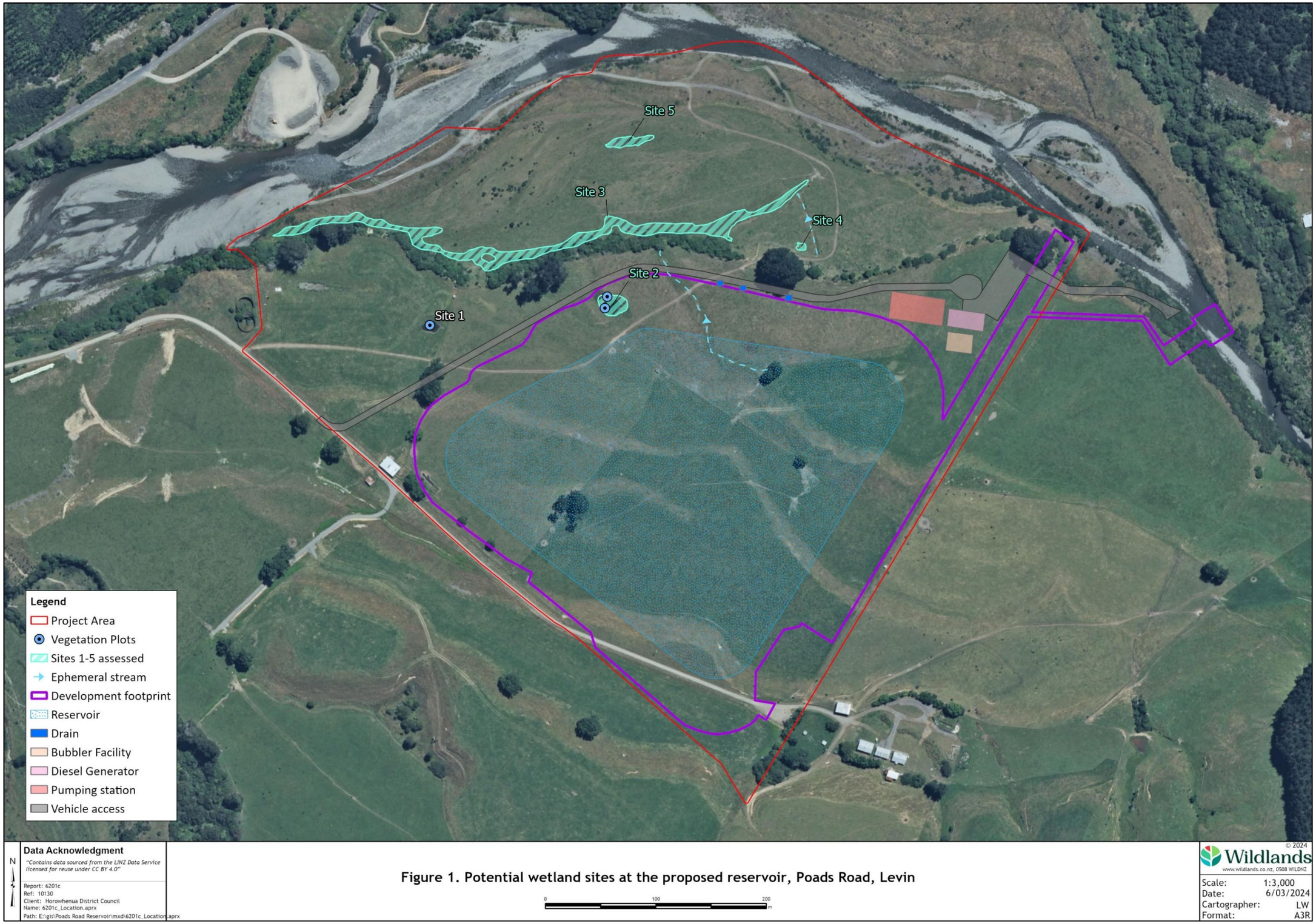


Figure 1. Potential wetland sites at the proposed reservoir, Poads Road, Levin

(e) a wetland that:

i. is within an area of pasture for grazing; and

ii. has vegetation cover comprising more than 50% exotic pasture species (as identified in the National List of Exotic Pasture Species using the Pasture Exclusion Assessment Methodology); unless

iii. the wetland is a location of a habitat of a threatened species identified under clause 3.8 of this National Policy Statement, in which case the exclusion in (e) does not apply.

According to this definition, the prerequisite for an area to be classed as a 'natural inland wetland' is for the area to meet the wetland definition under the RMA and not meet any of the five exclusions provided in the NPS-FM. This definition requires that both suitable hydrological conditions and that plants that are adapted to wet conditions are dominant in the area relative to exotic pasture species.

The New Zealand vegetation tool for wetland delineation (Clarkson 2013) has become the standard methodology to assess the presence of plants adapted to wet conditions. This methodology classifies all plant species that have been recorded in wetlands into five categories:

- OBL: Obligate. Is almost always a hydrophyte, rarely in uplands (estimated probability >99% occurrence in wetlands).
- FACW: Facultative Wetland. Usually is a hydrophyte but occasionally found in uplands (estimated probability 67–99% occurrence in wetlands).
- FAC: Facultative. Commonly occurs as either a hydrophyte or non-hydrophyte (estimated probability 34–66% occurrence in wetlands).
- FACU: Facultative Upland. Occasionally is a hydrophyte but usually occurs in uplands (estimated probability 1–33% occurrence in wetlands).
- UPL: Obligate Upland. Rarely is a hydrophyte, almost always in uplands (estimated probability <1% occurrence in wetlands).

Species that are classed as OBL, FACW, or FAC are considered hydrophytic and generally indicative of wetland habitat. The relative dominance of each species, and corresponding classification, can therefore determine whether an area should be defined as wetland. In addition, Fraser *et al.* (2018) provides the methodology for assessing wetland soils, and the criteria for identifying suitable wetland hydrology are outlined in the Ministry for the Environment wetland hydrology tool (2021). Areas with a dominance of hydrophytic vegetation, hydric soil characteristics, and the appropriate hydrological conditions can therefore be defined as a 'natural inland wetland'.

3.0 Wetland delineation

3.1 Overview

Of the sites previously identified as potential wetland habitats, two are on the upper terrace, where infrastructure is to be located, and only one was demarcated within the potential footprint of the proposed reservoir. The two sites on the upper terrace are located within a large area of paddock on the upper terrace above the Ohau River. These two sites are labelled as Site 1 and Site 2 in Figure 1. The remainder of the sites (3-5) are on the lower terrace (Figure 1).

Evaluations of each of these five sites are set out below.

3.2 Site evaluations

3.2.1 Site 1

Site 1 (Plate 1) is a small depression on the upper terrace that is dominated by Yorkshire fog with frequent creeping buttercup, Sweet vernal, and browntop with occasional white clover and soft rush. No hydrologic indicators were noted, and the soil profile was dry and very friable. The matrix colour was of a high chroma and is consistent with hydric soils.



Plate 1 — Site 1 is a small depression that has more than 50 percent cover of pasture species and meets the pasture exclusion test. No hydrologic indcators were present. 22 October 2023.

Site 1 is not considered to be a natural inland wetland as it meets the pasture exclusion criteria.

3.2.2 Site 2

Site 2 is a small open-water shallow depression covering an area of *c*.400 m^2, with a narrow fringe of wetland vegetation that includes jointed rush (*Juncus articulaus*, OBL), water purslane (*Ludwigia palustris*, OBL) with abundant Yorkshire fog (*Holcus lanatus*, FAC), Mercer grass (*Paspalum distichum*, FACW), creeping bent (*Agrostis stolonifera*, FACW) and occasional patches of (*Persicaria hydropiper*, FACW), creeping buttercup (*Ranunculus repens*, FAC) sweet vernal (*Anthoxanthum odoratum*, FACU), and white clover (*Trifolium repens*, FACU).



Plate 2 —Site 2 is a wet depression in a paddock on the upper terrace, with no apparent hydrologic surface connection. 22 October 2023.



Plate 3 — Site 2, spade at the edge of wetland Vegetation Plot 2, showing the shallow water depth. 22 October 2023.

Two representative 2 × 2 metre vegetation plots were assessed in the narrow strip of vegetation surrounding the small area of open water:

- The first vegetation plot (Vegetation Plot 1 – Site 2) met the Dominance Test and had a Prevalence Index score of 1.75 as the plot is dominated by OBL and FACW species (see Appendix 1). This would qualify the site as being classified as a natural inland wetland.

- The second vegetation plot (Vegetation Plot 2 – Site 2) met the Dominance Test and had a Prevalence Index score of 2.59, which indicates that it could be classified as a natural inland wetland. However, Vegetation Plot 2 also contains more than 50 percent of pasture species and meets the pasture exclusion criteria under the NPS-FM, so would not qualify as a natural inland wetland.

The hydrology noted during the site visit is inundated with saturated soil around the margins. No discernible surface connection could be detected flowing into or away from Site 2. The site is isolated and may only receive freshwater influence from precipitation, not functioning as part of the hydraulic regime of the wider terrace.

Two soil samples were taken at both vegetation data points, to a depth of 30 cm. The soil profile exhibited low chroma soil for the first 20cm with redoximorphic features with matrix colour and along the pore lining. At 20 cm, the soil has an abundance of alluvial rock and other materials and has become noticeably much drier. At depths beyond 20cm, the soil colour had a much higher chroma than the top 20cm of the profile and appeared no longer consistent with hydric soils. There seems to be a restrictive, impermeable layer of soil material that allows water to pool during wet times of the year.

Overall, the narrow band of vegetation surrounding the small area of open water habitat is a mosaic of wetland and pasture species, which means that the vegetation cover varies between less than or greater than 50 percent cover of pasture species. The ground around the open water is heavily pugged.

This site could be classified as a wetland but it is a very marginal classification.

3.2.3 Site 3

Site 3 (Plate 4) is a larger linear feature of *c.*4,000 m^2 that has formed at the toe of the slope of the upper stream terrace and is located within the floodplain of the Ohau River. Site 3 is generally inundated with variable depths, and saturated soil is common along the margins.

The cover and composition of wetland species changes often due to the size and elongated nature of the site. Locally abundant species within the inundated areas were water celery (*Helosciadium nodiflorum*, OBL), (*Isolepis prolifera*, OBL), water purslane (OBL), and starwort (*Callitriche stagnalis*, OBL). Frequently observed species along the margins included *Juncus sarophorus* (FACW), soft rush (*Juncus effusus*; FACW), creeping buttercup (FAC), Yorkshire fog (FAC), and creeping bent (FACW). Species occasionally present in patches around the edges were *Isolepis reticularis* (FACW), and water pepper (*Persicaria hydropiper*, FACW).



Plate 4 — Site 3 is dominated by water celery, water purslane, and starwort, with soft rush and *Juncus sarophorus* along the edge. 22 October 2023.

Site 3 is considered to be an inland natural wetland based on the NPS-FM.

3.2.4 Site 4

Site 4 (Plate 5) is a small wet area of *c*.50 m^2 that has formed in a shallow depression located along a farm track with a paddock on the lower steam terrace of the Ohau River. Site 4 has small patches of bare ground, and soils are hydric with low chroma matrix displaying redox. Soil saturation was observed below 20 cm of depth in the profile. The small site contained creeping buttercup (FAC), water purslane (OBL), and jointed rush (OBL).

Site 4 is considered to be a natural inland wetland.

3.2.5 Site 5

Site 5 (Plate 6) covers *c*.276 m^2 that has formed in a shallow depression located on the floodplain of the Ohau River. It is inundated, with areas of saturated soils around the margins. The site is dominated by water purslane (OBL), *Helosciadium nodiflorum* (OBL), *Isolepis prolifera* (OBL), and starwort (*Callitriche stagnalis*, OBL) with frequent Mercer grass (FACW), soft rush (FACW), and *Juncus sarophorus* (FACW).

Site 5 is considered to be a natural inland wetland.



Plate 5— Site 4 is a small depression dominated by water pepper, water purslane, and creeping buttercup. 22 October 2023.



Plate 6 — Site 5 is a narrow wetland mostly inundated and dominated by water purslane, *Isolepis prolifera*, and Mercer grass. 22 October 2023.

4.0 Horizons One Plan

Schedule RP-SCHED6 of the Horizons One Plan recognises various wetland types that are classified as 'Threatened' or 'Rare'. Two categories of wetland at the Poads Road site are relevant: 'ephemeral' wetlands and 'seepage and spring wetlands', both of which are classified as 'Rare'.

Site 1

This is not a wetland so wetland provisions in the One plan do not apply.

Site 2

'Rare' wetlands have a minimum size threshold in RP-SCHED6 of 0.05 hectares, i.e. 500 m^2. Site 2 on the upper terrace has no discernible surface water inputs other than precipitation and is likely to dry out, and can be classified as an ephemeral wetland, although highly degraded with pasture species prominent.

However, it does not meet the minimum size threshold of 500 m^2 so is not significant in terms of the One Plan. It should be noted that although, technically, this site could qualify as a wetland, albeit

marginally, in terms of the NPS-FM, it is highly modified, the vegetation is predominantly exotic, and it is not ecologically significant. It also has little potential for ecological restoration.

Site 3

This is a seepage wetland that meets the size threshold in RP-SCHED6 of the One Plan, which means that it is classified as 'Rare'. Because of its size (*c.*4,000 m^2) and location it has potential for ecological restoration.

Site 4

This site is probably ephemeral and is very small (*c.*50 m^2) and does not meet the size threshold in RP-SCHED6 of the one Plan. In isolation, it has little potential for ecological restoration.

Site 5

This is another small (*c.*276 m^2) highly-modified wetland that doesn't meet the size threshold in RP-SCHED6 of the Horizons One Plan.

5.0 Management of potential effects

The NPS-FM provides an effects management hierarchy, in relation to natural inland wetlands and rivers, which comprises an approach to managing the adverse effects of an activity on the extent or values of a wetland or river (including cumulative effects and loss of potential value) that requires that: (a) adverse effects are avoided where practicable; then (b) where adverse effects cannot be avoided, they are minimised where practicable; then (c) where adverse effects cannot be minimised, they are remedied where practicable; then (d) where more than minor residual adverse effects cannot be avoided, minimised, or remedied, aquatic offsetting is provided where possible; then (e) if aquatic offsetting of more than minor residual adverse effects is not possible, aquatic compensation is provided; then (f) if aquatic compensation is not appropriate, the activity itself is avoided.

Site 2 will potentially fall under the footprint of the proposed reservoir so will be lost. Due to its small and degraded nature, this loss can be offset by the restoration of the degraded wetlands on the lower terrace.

Sites 3-5 are on the lower terrace and will not be directly affected. There is potential, although unlikely, for indirect effects due to sediment inputs during construction activity on the upper terrace and possibly due to changes in surface and subsurface flows.

The potential for adverse effects can be avoided by implementing the following:

- Appropriate controls on sediment management during the construction phase.
- Maintaining the opportunity for surface flows from the upper terrace to travel to the lower terrace.

Ecological restoration of the lower terrace would easily outweigh the adverse effects of very minor 'losses' on the upper terrace. An Ecological Restoration Plan could be prepared to guide this and could address the following:

- Definition of the area subject to the plan.
- Stock exclusion.
- Wetland planting.
- Wetland riparian planting.

- Terrestrial planting.
- River riparian planting (subject to the extent of the area to be restored).
- Monitoring and maintenance of plantings.
- Pest animal monitoring and control.
- Restoration/planting targets.
- Reporting.

6.0 Discussion and Summary

The property proposed for the Reservoir at Poads Road, Levin, contains five sites that were identified as potential wetlands along the lower floodplain and upper stream terrace of the Ohau River, and all of these sites have now been subject to a further wetland delineation assessment.

Site 2, on the upper terrace, is a 'marginal' very small and highly degraded wetland which could potentially be impacted by the proposed reservoir works. This site is a shallow, isolated feature that comprises a mosaic of wetland and pasture species. Site 2 did not have an apparent hydrologic surface connection and is most likely seasonal (i.e. ephemeral; drying out over summer) with little influence on the hydrologic regime. As such, it is of very limited ecological value.

It is not anticipated that Sites 3-5 on the lower terrace will be directly affected by construction of the proposed reservoir and associated infrastructure. Sites 1, 2, 4, and 5 do not meet the size threshold in the Horizons One Plan.

Construction of the reservoir may be a discretionary activity in terms of National Environmental Standards for Freshwater: construction of specified infrastructure – Urban development (45C Discretionary activities).

Restoration of the wetland areas on the lower floodplain of the Ohau River would easily mitigate the loss of Site 2, and this approach would very substantially outweigh the minor adverse effects associated with the loss or modification of this small, highly modified 'marginal' wetland.

An Ecological Management Plan should be provided for restoration of the lower stream terrace.

Acknowledgments

Annette Sweeney from Good Earth Matters Consulting Ltd is thanked for providing site access and project liaison, and Neil Carr is thanked for providing updated site plans and background information.

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Appendix 1

Vegetation plot information

Site 1 Vegetation Plot 1

Vegetation Plot Data						
Stratum	**Species Name**	**Common Name**	**% Cover**	**Dominant?**	**Indicator Status**	**Pasture Species?**
Herb 2 x 2 m	*Holcus lanatus*	Yorkshire fog	60	YES	FAC	Y
	Ranuculus repens	Tāwheowheo	15	NO	UPL	N
	Anthoxanthum odoratum	Sweet vernal	10	NO	FACU	Y
	Agrostis capillaris	Browntop	8	NO	FACU	Y
	Trifolium repens	White clover	5	NO	FACU	Y
	Juncus effusus	Soft rush	5	NO	FACW	N
	Juncus sarophorus		3	NO	FACW	N
		Total Cover:	106			
		20% Cover:	21			
		50% Cover:	53			

Dominance Test	
Number of dominant species OBL, FACW, or FAC (A) =	1
Total number of dominant species across all strata (B) =	1
Percent of dominant species that are OBL, FACW, or FAC (A/B) =	100%
Wetland vegetation determination =	**WETLAND**

Prevalence Index			
Indicator Status	**Total % Cover**	**Multiplication Factor**	**Mulitplied % Cover**
OBL	0	x 1 =	0
FACW	8	x 2 =	16
FAC	60	x 3 =	180
FACU	23	x 4 =	92
UPL	15	x 5 =	75
Total (A)	106	Total (B)	363
		Prevalence Index (B/A) =	3.42
		Wetland vegetation determination =	**NOT WETLAND**

Pasture Exclusion Test	
Pasture Species Cover =	83
Total Vegetation Cover =	106
% Cover of Pasture Species =	78%
Pasture determination =	**PASTURE**

Soil Analysis						
Depth	**Matrix Colour**	**Mottles Colour**	**Mottles %**	**Mottle Location**	**Material**	**Comments**
0-20	10YR 4/4	7.5YR 5/6	2%	Pore lining & matrix	Mineral soil	friable/ very dry
			Location	Flat		
			Water table depth (cm)	0		
			High groundwater	0		
			Pan	0		

Soil Analysis						
Depth	**Matrix Colour**	**Mottles Colour**	**Mottles %**	**Mottle Location**	**Material**	**Comments**
			Pan depth (cm)	0		
			Pugged	0		
			Wetland soil determination =	**NOT WETLAND**		

Wetland hydrology	
Total No. Primary Indicators =	0
Total No. Secondary Indicators =	0
Wetland hydrology determination =	**NOT WETLAND**

Site 2 Vegetation Plot 1

Vegetation Plot Data						
Stratum	**Species Name**	**Common Name**	**% Cover**	**Dominant?**	**Indicator Status**	**Pasture Species?**
Herb 2 x 2 m	*Juncus acuminatus*	Sharp-fruited rush	40	YES	OBL	N
	Ludwigia palustris	Water purslane	12	NO	OBL	N
	Paspalum distichum	Mercer grass	10	NO	FACW	N
	Holcus lanatus	Yorkshire fog	10	NO	FAC	Y
	Ranunculus repens	Creeping buttercup	10	NO	FAC	N
	Anthoxanthum odoratum	Sweet vernal	5	NO	FACU	Y
		Total Cover:	87			
		20% Cover:	17			
		50% Cover:	44			

Dominance Test	
Number of dominant species OBL, FACW, or FAC (A) =	1
Total number of dominant species across all strata (B) =	1
Percent of dominant species that are OBL, FACW, or FAC (A/B) =	100%
Wetland vegetation determination =	**WETLAND**

Prevalence Index			
Indicator Status	**Total % Cover**	**Multiplication Factor**	**Multiplied % Cover**
OBL	52	x 1 =	52
FACW	10	x 2 =	20
FAC	20	x 3 =	60
FACU	5	x 4 =	20
UPL	0	x 5 =	0
Total (A)	87	Total (B)	152
		Prevalence Index (B/A) =	1.75
		Wetland vegetation determination =	**WETLAND**

Pasture Exclusion Test	
Pasture Species Cover =	15
Total Vegetation Cover =	87
% Cover of Pasture Species =	17%
Pasture determination =	**NOT PASTURE**

Soil Analysis						
Depth	**Matrix Colour**	**Mottles Colour**	**Mottles %**	**Mottle Location**	**Material**	**Comments**
0-10	10YR 3/1	10YR 5/6	2%	Pore lining	Mineral soil	0
10-20	10YR 4/2	7.5YR 4/4	15%	Matrix	Mineral soil	very rocky under 20cm
20-30	10RY 5/4	7.5RY 4/6	20%	Matrix	Mineral soil	Not hydric, High chroma matrix colour

Location	Flat
Water table depth (cm)	0
High groundwater	0
Pan	YES
Pan depth (cm)	20cm
Pugged	YES
Wetland soil determination =	Wetland soil present between 0-20cm. After 20cm soil become dry with high chroma matrix.

Wetland hydrology	
Surface water (1A)	Primary Indicator
Soil saturation <30 cm (1C)	Primary Indicator
Total No. Primary Indicators =	2
Total No. Secondary Indicators =	1
Wetland hydrology determination =	**WETLAND**

Site 2 Vegetation Plot 2

Vegetation Plot Data						
Stratum	**Species Name**	**Common Name**	**% Cover**	**Dominant?**	**Indicator Status**	**Pasture Species?**
Herb 2 x 2 m	*Holcus lanatus*	Yorkshire fog	40	YES	FAC	Y
	Juncus acuminatus	Sharp-fruited rush	20	NO	OBL	N
	Paspalum distichum	Mercer grass	20	NO	FACW	N
	Trifolium repens	White clover	7	NO	FACU	Y
	Agrostis capillaris	Browntop	5	NO	FACU	Y
	Anthoxanthum odoratum	Sweet vernal	5	NO	FACU	Y
	Agrostis stolonifera	Creeping bent	5	NO	FACW	N
	Ludwigia palustris	Water purslane	3	NO	OBL	N
		Total Cover:	105			
		20% Cover:	21			
		50% Cover:	53			

Dominance Test	
Number of dominant species OBL, FACW, or FAC (A) =	1
Total number of dominant species across all strata (B) =	1
Percent of dominant species that are OBL, FACW, or FAC (A/B) =	100%
Wetland vegetation determination =	**WETLAND**

Prevalence Index			
Indicator Status	**Total % Cover**	**Multiplication Factor**	**Mulitplied % Cover**
OBL	23	x 1 =	23
FACW	25	x 2 =	50
FAC	40	x 3 =	120
FACU	17	x 4 =	68
UPL	0	x 5 =	0
Total (A)	105	Total (B)	261
		Prevalence Index (B/A) =	2.49
		Wetland vegetation determination =	**WETLAND**

Pasture Exclusion Test	
Pasture Species Cover =	57
Total Vegetation Cover =	105
% Cover of Pasture Species =	54%
Pasture determination =	**PASTURE**

Soil Analysis						
Depth	**Matrix Colour**	**Mottles Colour**	**Mottles %**	**Mottle Location**	**Material**	**Comments**
0-10	10YR 3/1	10YR 5/6	2%	Pore lining	Mineral soil	0
10-20	10YR 4/2	7.5YR 4/4	10%	Matrix	Mineral soil	very rocky under 20cm
20-30	10RY 5/4	7.5RY 4/6	20%	Matrix	Mineral soil	not wet, High chroma
				Location	Flat	
				Water table depth (cm)	0	
				High groundwater	0	
				Pan	YES	
				Pan depth (cm)	20cm	
				Pugged	YES	
				Wetland soil determination =	**WETLAND**	

Wetland hydrology	
Surface water (1A)	Primary Indicator
Soil saturation <30 cm (1C)	Primary Indicator
Total No. Primary Indicators =	2
Total No. Secondary Indicators =	0
Wetland hydrology determination =	**WETLAND**

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LIZARD SURVEY OF A SITE PROPOSED FOR A WATER STORAGE RESERVOIR AT POADS ROAD, LEVIN [1]

Cameron Thorp
17 October 2022

INTRODUCTION

Good Earth Matters Ltd is preparing a resource consent application, on behalf of Horowhenua District Council (HDC), to construct a new water reservoir and increase the currently consented water take from the Ohau River at Poads Road near Levin. On behalf of HDC, Good Earth Matters commissioned Wildland Consultants Ltd to undertake a lizard survey to assess whether the project will potentially affect indigenous lizards. All indigenous lizard species are protected under the Wildlife Act 1953, and therefore must not be harmed, disturbed or killed without a Wildlife Act authorisation issued by the Department of Conservation.

Wildland Consultants (2022) previously undertook an ecological assessment of the site, which included vegetation mapping, a lizard desktop assessment, and identified the requirement for a lizard survey. The desktop assessment identified no lizard records for the site.

The project area occupies a series of alluvial terraces adjacent to the Ohau River and covers *c*.28.7 hectares, most of which is exotic pasture. There is a band of mixed indigenous broadleaved species forest and māhoe (*Melicytus ramiflorus* subsp. *ramiflorus*) treeland on a hillslope, and there are several stonefields/formed rock piles in the pasture, as well as along the base of the forested hillslope. These habitats, particularly areas containing rock piles, deep leaf litter, and dense vegetative groundcover, were identified as potentially providing habitat for indigenous lizards and were therefore targeted as part of the lizard survey.



Plate 1: One of the rock piles in exotic grassland that was surveyed for lizards. 12 January 2022.

[1] Reviewed and approved for release by William Shaw.

METHODS

Thirty pitfall traps (Figure 1) were set up and subsequently checked over the period 2-4 March 2022, with three checks of each trap, totalling 90 trap nights. Following the survey, all survey equipment was removed.

The survey was undertaken during warm, sunny weather conditions (when lizards are most active): with temperatures ranging between 14-22 degrees Celsius, rainfall of 0-0.2 millimeters per 24 hours, and calm to light winds (0-2 on the Beaufort scale).

Hand-searching was undertaken opportunistically across the site during the survey period where appropriate habitat was present. This involved searching for lizards in potential refuges, such as under rocks and pieces of wood.

FINDINGS

No lizards were detected at the site during the lizard survey.

CONCLUSIONS

There are some areas of habitat that appear to be potentially suitable for lizards, particularly rock piles, which could potentially provide sufficiently complex habitat for lizards to survive in. However, at least some of these piles have been artificially formed by removing rocks from the surrounding farmland prior to cultivation/ploughing (Wildland Consultants 2022). This habitat modification, and predation from introduced mammals, may have resulted in the extirpation of lizards prior to the creation of the rock piles. Alternatively, the rock piles may provide insufficient protection from mammalian predators such as mice, which are able to squeeze into small spaces.

Indigenous lizards are cryptic and can be difficult to detect, especially when at low densities. There are either no lizards present at the site, or they are present in such low densities as to be undetectable without extraordinary survey effort. Habitat modification and predation pressure from introduced mammals are likely to be the main reasons for the lack of lizards in the area. If lizards are present, but below detection levels, the most likely undetected species is northern grass skink (*Oligosoma polychroma* - 'Not Threatened'[1]), which is widespread in the southern North Island and known to be able to persist in disturbed and marginal habitat. However, based on the survey results, there is high confidence that lizards are not present and no further lizard management is necessary at this site.

[1] National threat classification from Hitchmough *et al*. (2021).

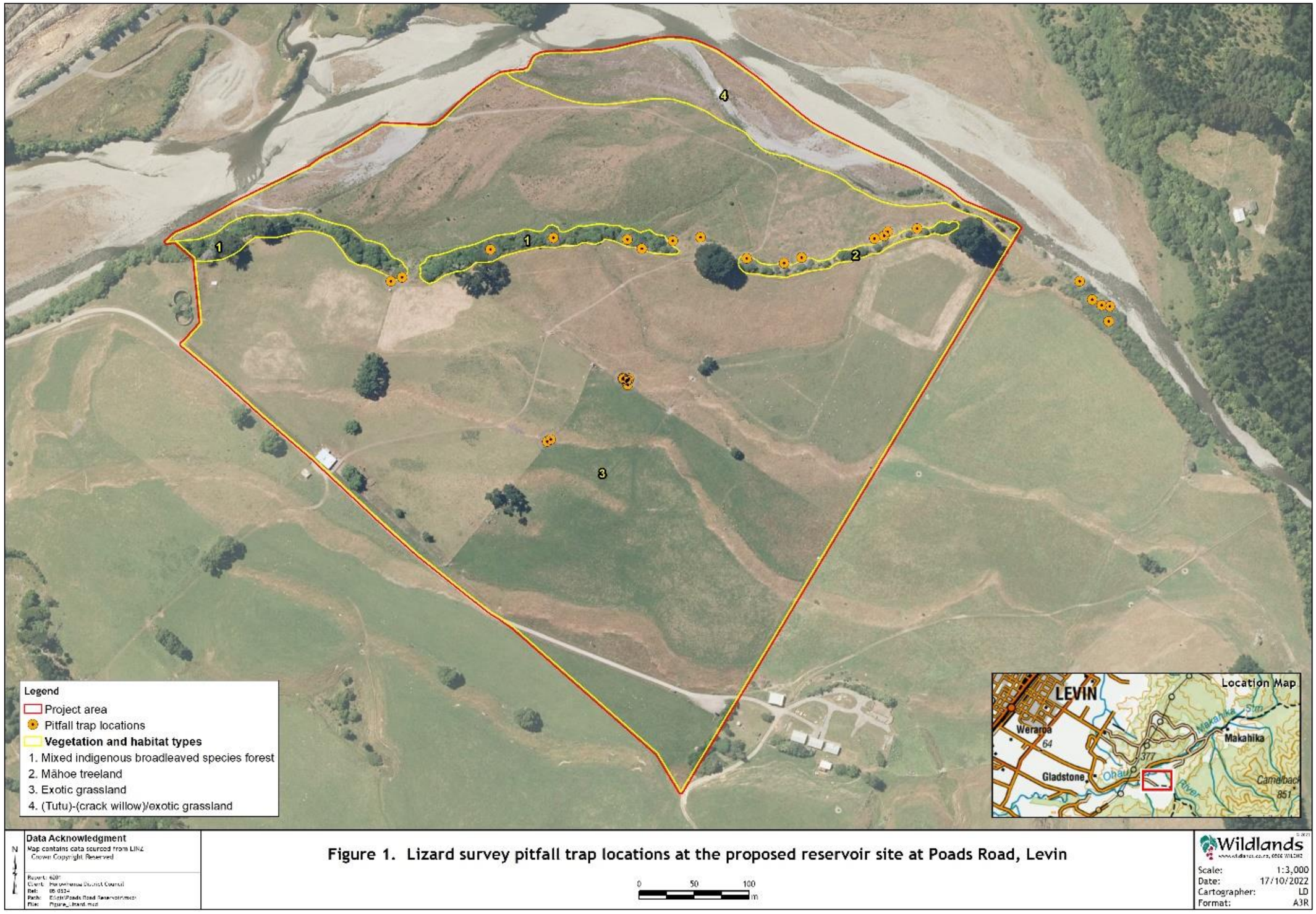


Figure 1. Lizard survey pitfall trap locations at the proposed reservoir site at Poads Road, Levin

ACKNOWLEDGMENTS

Annette Sweeny from Good Earth Matters Ltd is thanked for initiating this project and providing project liaison, along with Kaitlin Hubbard from Horowhenua District Council.

REFERENCES

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Wildland Consultants 2022: Stage 1 Ecological Assessment for a proposed Water Storage Reservoir at Poads Road, Levin. *Wildland Consultants Ltd Contract Report No. 6201*. Report prepared for Horowhenua District Council. 31 pp.

Appendix I

CONSTRUCTION MANAGEMENT PLAN CONTENT

MEMORANDUM

POADS ROAD WATER ABSTRACTION CONSTRUCTION EFFECTS AND MANAGEMENT PLAN REQUIREMENTS

For: Levin Water Supply - Water Harvesting and Resilience Project AEE

Date: July 2024

INTRODUCTION

This memorandum sets out the proposed construction methodology for the new reservoir intake and associated works in the riparian area for the Levin Water Supply Water Harvesting and Resilience Project. It draws on the construction methodology detailed in the Preliminary Design Report (Damwatch, March 2023), and develops how this methodology can be implemented in a way which is consistent with regional and national guidance for undertaking works in waterbodies. It identifies the potential construction effects involved with the proposed works, and details how these potential construction effects will be managed including all required construction management plans and what each of those plans are required to address.

Overall, the following confirms that there is confidence that best practice principles established in regional and national guidance can be followed, and adverse environmental effects can be avoided and/or mitigated during the proposed construction.

PROPOSED RESERVOIR AND CONSTRUCTION METHODOLOGY

Damwatch Engineering Ltd has prepared the Feasibility Design Report dated 17 March 2023 for the Poads Road Water Storage Reservoir. That report sets out the objectives, constraints and development of the feasibility design for the reservoir and related facilities. The report notes the scheme arrangement consists of:

- An infiltration galley buried into the bed of the Ohau River, capable of extracting a variable flow up to 400 l/s along with a facility for backflushing the riverbed to maintain the efficiency of the intake.
- A single reservoir with a maximum depth of approximately 14 m when full (Full Supply Level, FSL), bounded by a broad earth embankment reservoir. Most of the materials for the embankment will be won and processed from the gravels on site. The internal face of the embankment is protected by a geosynthetic membrane. The combination of the membrane and robust embankment arrangements provides resilience against seismic loads derived from nearby earthquake sources.
- Offtake facilities arranged to be more resilient than conventional offtakes arrangements, in recognition of the seismic loads this site may encounter.
- Twin rising mains; the material for these is flexible and durable high-density polyethylene.
- A new pipe bridge over the Ohau River, just upstream of the existing Poads Road bridge. The bridge is to have one fixed abutment and the other can move to allow for fault movement in an earthquake on the North Ohariu Fault.
- Facilities to support the asset, such as an access road to Poads Road, power transmission poles, and a compressed air generator to maintain water quality in the reservoir and provide air for backflushing the intake gallery.

This memorandum is concerned only with the construction methodology for the river intake and riparian works and pipe bridge being the first bullet point listed above. Management of construction effects for the reservoir and associated infrastructure are detailed in a separate Erosion and Sediment Control Plan, while the rising main works will be subject to the road control authority requirements and do not require a resource consent.

River Intake & Riparian Works

Within the Damwatch Report, Section 20.0 - Constructability, and specifically Section 20.5 - River Intake detail the anticipated construction sequence for the Intake. In developing this sequence best practice techniques are incorporated, as detailed in the Ministry for the Environment's publication National Works in Waterways Guideline - Best Practice Guide for Civil Infrastructure Works and Maintenance, July 2021. The following text in italics is direct from the Damwatch report.

1. *Construction of a channel to divert the river flow away from the intake construction footprint.*
    a. *Construction works are to be undertaken in low flow seasons to reduce river levels. Discussions with Fish and Game should be initiated to align works with non-critical times for fish spawning and migration.*

    Notwithstanding that Damwatch has only identified discussions with Fish and Game, the applicant will engage with mana whenua with respect to fish relocation and ensure that there is an opportunity for appropriate tikanga to be undertaken and that there is prior notification of the proposed works. Further, any other necessary approvals under other legislation or regulation will be sought if needed. Fish relocation will also be undertaken after construction and prior to closing off the temporary diversion channel (to relocate fish from the temporary diversion channel back into the main stem of the river).

2. *Depending on anticipated river flows and natural groundwater levels, construction of further barriers may be required, such as Aquabarrier, bunds and supplemented by temporary sumps and pumps to intercept groundwater flow entering the excavation.*
    a. *These temporary sumps and pumps in the riverbed would likely be installed at low points at the edge of the proposed infiltration gallery footprint.*
        i. *Suitable fish screens or covers can minimise the drawing of freshwater fauna into the pumps.*
    b. *Robust sediment control techniques, such as silt fences, will minimise construction impacts.*
3. *The infiltration gallery area will be excavated by suitable plant to the design level below the riverbed.*
    a. *Larger material encountered in the riverbed will be harvested and stockpiled for later use on the riverbed surface of the completed infiltration gallery.*
    b. *Permeable gravel drainage material will be placed to the design thickness inside gabion basket type structures, and compacted to appropriate standards in the gallery footprint.*
    c. *Perforated pipes and backwash pipework will be placed in drainage material so that it surrounds and covers the pipework in the gabion basket.*
    d. *Harvested material will be placed over the permeable gravel layer to provide an armouring to the riverbed and riverbanks to inhibit general riverbed scour.*
4. *Shallow trenches from the infiltration pipework to the sedimentation sumps will be excavated and pipes installed to join the infiltration galleries to the sumps. Pipework will be installed with suitable drainage material surround.*
5. *The sedimentation sump and submersible pump sump will be constructed in the nearest river terrace by a suitable excavator, either by trenching in from the riverbank or excavation from ground surface. The approach is still to be assessed and determined.*
    a. *Each sump will be constructed by*
        i. *Forming a cast in-situ reinforced base slab (approx. 500-700 mm thickness),*
        ii. *Placing sections of pre-cast concrete rings installed which will form the permanent formwork for the cast in situ structural wall.*
        iii. *Pre-cast concrete rings will be soaked prior to placement.*
        iv. *The internal structural wall will be cast in place concrete.*
        v. *Natural soils and gravel will provide the backfill surround.*
6. *Two platforms will be cut in to reduce the height of both the sump and sedimentation manhole.*
    a. *Cuts will be stabilised using Mechanically Stabilised Earth slopes or similar.*
    b. *Appropriate fencing / guard rails will be provided on the crest of the riverbank for Health and Safety.*

c. *River protection works will be constructed along the river in the location of the galleries. Protection measures are likely to be riprap revetments toes into the riverbed.*

7. *Upon completion of the river works all diversion features and equipment will be removed and the riverbed restored.*

Other considerations:

1. *Access to the site will be created from the closest riverbank / terrace. Vegetation clearance will be required.*
2. *Suitable plant will be determined by the preferred Contractor. Excavators are likely to be 20 tonnes or more.*
3. *It is anticipated that machinery working in the river, in accordance with approved method statements, will be sprayed down and washed prior to river entry in a suitable bunded location, to minimise and avoid the spread of freshwater plant and animal pests, and discharge of contaminants.*

Note: in addition to the above, all appropriate biosecurity measures will be adopted as may be required under the Biosecurity Act (ie the requirement under this Act to not spread invasive freshwater weeds and pests) and as per the most recent guidance from Ministry of Primary Industries.

4. *Fuels and other chemicals for plant will be stored away from the waterways and above the anticipated flood levels.*
5. *Any riverbank zones not required for permanent access will be reinstated to their previous contours and revegetated and river protection.*

The period required to complete the works is dependent on the weather conditions at the time of undertaking the works. The expected construction period for the river works and civil works in the riparian zone is less than 2 months. As far as possible, this will be planned to occur during periods of settled weather. The contractor will also be required, as a condition of contract, to ensure that all machinery and equipment is in place prior to commencing river works in order to minimise potential for delays in completing this aspect of the project.

POTENTIAL CONSTRUCTION EFFECTS AND BEST PRACTICE APPROACH FOR THE RIVER INTAKE STRUCTURE

In order to avoid, remedy, or mitigate any potential adverse environmental effects arising from the proposed activity, a series of management plans will be developed to detail how the proposed construction can be undertaken in a way which minimises environmental effects. Conditions of consent are required to ensure that these management plans are prepared and are provided to the Regional Council for technical certification to ensure that the matters set out below are adequately addressed prior to construction of the river and riparian works commencing. Ideally, these management plans will be prepared as a single integrated construction management plan for the works.

This section has been developed to demonstrate how the proposed works may be undertaken in accordance with the best practice principles detailed in the National Works in Waterways Guideline published by the Ministry for the Environment in July 2021 and regionally specific Erosion and Sediment Control Guidelines for Land Disturbing Activities in the Wellington Region dated February 2021, with particular regard for Section G4.0 – Works within a watercourse. This section expands on the proposed construction methodology discussed above.

Below are the potential construction effects of the proposed activity, and a table of the best practice principles set out within the National Works in Waterways Guideline, and how each principle will be implemented on site including potential best practice methodology, in order to reduce the potential construction effects.

Potential Effects Associated with the Proposed Works

Three key areas of the proposed activity have been identified as having potential adverse environmental effects due the proposed activity. These are identified in the Wildland Consultants 'Ecological Assessment of a Proposed Intake Structure for Poads Road Reservoir, Levin' dated January 2023 and are summarised below.

- Excavation of the riverbed and diversion of river flow
  - Use of heavy machinery in and around the Ohau River has the potential to liberate large volumes of sediment during the excavation of the riverbed and banks, as well as large scale disturbance of the in-stream habitat and potential mortality of indigenous fish species.
  - Diversion of flow around the impact reach will also temporality eliminate all aquatic habitat for indigenous fish and invertebrates in this area.
- Construction of bank armouring
  - This will require the complete removal of all riparian vegetation within this area. This will be replaced with a layer of rock rip-rap.
  - These works occur immediately adjacent to the river channel, and therefore, there is a high risk of sediment discharges occurring if appropriate control measures are not implemented.
- Construction of emergency spillway, access road and intake infrastructure
  - Extensive earthworks will be required, and the removal of some riparian vegetation on the true left bank of the river. The ecological assessment found that most of this area, which will be cleared for the works, is open farmland covered with pasture grasses and the amount of riparian vegetation to be removed is less than what is required for bank armouring above.

Best Practice Principles for Works in Waterways

Table 1 below demonstrates how the proposed construction works will be implemented on-site following the best practice principles as set out by the National Works in Waterways Guidelines published by the Ministry for the Environment in July 2021 and regional guidance as identified above.

Table 1: Best Practice Principles for Works in Waterways and How this Principle will be Implemented Onsite

Best practice principles for works in waterways	How this principle may be implemented on-site following best practice methodology
Avoid in-stream works as a first principle	Due to the nature of the proposed activity, in-stream works must occur. Best practice principles will be implemented to reduce the effects of the proposed works. Following best practice, the construction works will be undertaken in the dry to minimise sediment discharges to the river, and in accordance with the Erosion and Sediment Control Plan prepared for this work. This will be carried out by installing a temporary diversion of the active channel within the bed of the river following best practice principles specified in the National Works in Waterways Guideline and regionally specific Erosion and Sediment Control Guidelines for Land Disturbing Activities in the Wellington Region with particular regard for section G4.0. The temporary diversion channel will be constructed as per G4.2.3 of the regional guidance and will minimise sediment generation and discharge from works within the watercourse, following the methodology detailed in the Erosion and Sediment Control Plan. The length of the watercourse to be diverted will be kept to the minimum necessary to enable safe and efficient construction. This also reduces the affected riverbed area which is required for the diversion.
Critically assess the operational methodology	As the works are undertaken, the operational methodology will continue to be critically assessed to ensure that the activity is completed in a way which minimises environmental effects. Qualified and competent contractors will be engaged for the duration of the project and this will be a matter that is taken into account in the procurement process for the contract.

Best practice principles for works in waterways	How this principle may be implemented on-site following best practice methodology
Maintain the streambed profile	The proposed construction works will ensure that any riverbank zones not required for permanent access will be reinstated to their previous contours and revegetated, or rip-rap river protection will be installed. The streambed profile will be maintained after the construction of the intake. Survey will be undertaken prior to the works commencing to confirm the current profile. Once works commence, the existing streambed material will be removed and stockpiled for later use. Following the completion of the works, the stockpiled material will be re-laid generally in accordance with the same bed profile as prior to the works commencing in order to restore the run-riffle-pool sequence of the river bed. Overall, the proposed works will not reduce habitat quality and will not create ongoing erosion issues post-construction.
Retain vegetation on the bank	Vegetation on the bank will be retained wherever possible, and as per the above, riverbank zones not required for permanent access will be revegetated. This includes affected areas as part of the river diversion. Where riparian vegetation must be cleared, disturbance to the river will be minimised by felling vegetation away from the river. Felled vegetation is to be left in-place on the ground for 2-3 days to allow for passive dispersal of terrestrial fauna from the felled vegetation.
Stabilise exposed areas as soon as possible	The banks will be stabilised to avoid erosion and sediment discharge into water as soon as reasonably practicable. Immediate stabilisation methods such as using geotextile products will be utilised, and follow all relevant protocols and procedures specified in the Erosion and Sediment Control Plan.
Avoid using synthetic materials for in-stream and riparian applications	Biodegradable stabilisation and plant protection options (e.g., entirely biodegradable hessian matting, Combi plant guards) will be utilised for bank stabilisation. This will ensure plastic remnants from synthetic materials cannot enter the environment.
Avoid discharge of sediment into water	The proposed work will be carried out using best practice for works within a watercourse outlined in the National Works in Waterways Guideline and regionally specific Erosion and Sediment Control Guidelines for Land Disturbing Activities in the Wellington Region with particular regard for section G4.0. An Erosion and Sediment Control Plan has been developed as a draft for the purposes of the consent application, and will be updated and finalised prior to construction taking place and provided to the Regional Council for technical certification.
Avoid sediment release downstream	The construction of the stream diversion and required bank works is an area that has the highest potential for sediment release downstream. These works will be carried out using best practice principles and operating under a robust erosion and sediment control plan to avoid sediment release. As part of this, all construction activities will be closely monitoring (as detailed in the Erosion and Sediment Control Plan) during construction, before and after every rainfall event, to ensure devices are operating as anticipated, and to ensure sediment release downstream is avoided.
Implement robust erosion and sediment control measures	Appropriate erosion and sediment control measures will be in place to avoid fine sediment entering waterways during works in or adjacent to waterways. An Erosion and Sediment Control Plan has been developed as a draft for the purposes of the consent application, and will be updated and finalised prior to construction taking place and provided to the Regional Council for technical certification.
Avoid discharge of contaminants onto riverbeds or into waterways	A spill response plan will be developed prior to construction works taking place. This will address the potential impacts of the construction of the proposed works, which will ensure the following is procedures are in place: • All refuelling of machinery will occur outside of the waterway and in a place where no fuel can enter the waterway if it is spilled. • Ensuring fuels and other chemicals are stored safely away from waterways, and spill kits are available for immediate use for any chemical fuel or other spill. • Store all machinery and equipment above the anticipated flood level at the end of each working day and/or when the site is unattended.

Best practice principles for works in waterways	How this principle may be implemented on-site following best practice methodology
Avoid impediments to free passage	As part of the construction works, fish passage will be maintained or only temporarily disrupted during activities (eg during the creation of the diversion channel and fish relocation processes both prior to and following the construction works). The diversion channel will be constructed to allow for fish passage.
Avoid disturbance and mortality of freshwater fauna	Due to the proposed works, the excavation of the riverbed will result in some short term disturbance to freshwater fauna. This area will be minimised as far as reasonably practicable. The Wildlands Ecological Assessment for the proposed intake works dated January 2023 notes that once the diversion channel is decommissioned and flow resumes within the main river channel, it is expected that the river will return to its natural form due to the bed movement during flood events. Fish relocation will be undertaken prior to the works commencing with a Fish Management Plan prepared in consultation with tangata whenua and all necessary approvals obtained prior to commencing. Fish relocation from the temporary diversion channel will also be undertaken prior to the flow being rediverted back into the permanent channel. It is acknowledged that while fish relocation will be carried out, it is not practical or possible to relocate macroinvertebrate species from the construction area. The effects on macroinvertebrate species will be minimised as far as possible by ensuring the disturbed area is kept to the minimum necessary to safely undertake the works. Given the short duration of the construction period, the effects of this disturbance are expected to be similar to a large flood flow which disturbs such species and the resultant time for macroinvertebrate species to re-establish. Any water take pumps which may be necessary (eg for dewatering) will be screened with appropriately 2–3-millimetre mesh to avoid fish mortality due to being drawn into the pumps. The Guideline outlines best practice protocols for fauna relocation and salvage protocol which will be included in a Fish Management Plan prior to construction.
Avoid in-stream works during critical spawning and migration periods	The works will be undertaken at a time to avoid critical spawning and migration periods. The area of the proposed works is not identified as being valued for trout or inanga spawning under the One Plan, nor is it identified as a site of significance - riparian and therefore the exclusion periods specified in Table 15 of the One Plan do not apply.
Avoid the spread of freshwater plant and animal pests	All appropriate biosecurity measures including requirement of the Biosecurity Act and most recent guidance from Ministry of Primary Industries will be followed for any machinery working in the river. In accordance with approved method statements, machinery will be sprayed down and washed prior to river entry in a suitable bunded location, to minimise and avoid the spread of freshwater plant and animal pests, and discharge of contaminants.
Avoid archaeological or wāhi tapu (sacred) sites	The proposed site location does not include any known archaeological or wāhi tapu (sacred) sites. Conditions of consent and contract will be imposed requiring an accidental discovery protocol to be followed. If any artefacts, taonga or similar are identified, works will cease immediately and the relevant hapu, Regional Council and Heritage New Zealand Pouhere Taonga will be informed.

Overall, the assessment provided above demonstrates with confidence that the activity can be undertaken in a way which minimises environmental effects by adopting and implementing best practice guidelines.

REQUIRED MANAGEMENT PLANS

Prior to construction taking place, environmental management plans will be prepared and provided to Regional Council for technical certification. It is considered appropriate that these plans be developed at that time, following completion of detailed design and appointment of a contractor such that the plans reflect the actual construction methodology to be followed. These plans will provide further detail of construction and operational methodology following best practice guidelines such that the activity can occur while avoiding and or mitigating adverse environmental effects.

The ecological assessment has recommended that the following plans be prepared:

- Erosion and Sediment Control Plan (a draft has been developed and is included with the application)
- Spill response plan
- Fish management plan
- Riparian planting.

In addition to the above plans, it is further recommended that a Flood Contingency Plan also be prepared.

Note that any consent conditions need to retain the flexibility for the matters to be addressed in these plans to be provided via a single integrated Construction Management Plan (or Plan with a similar title) and not necessarily require that a series of discrete separate plans be provided. It is often preferrable from an implementation perspective for there to be a single management plan to guide the contractor and site personnel as to how to ensure that they undertake the work in a way which minimises environmental effects.

Below sets out the objective / purpose of each of the plans and the minimum content required in each plan to ensure the activity addresses and mitigates the potential environment effects. These matters are expected to be included in conditions of consent setting out the requirements for these management plans.

Erosion and Sediment Control Plan

The purpose of an Erosion and Sediment Control Plan (ESCP) is to identify the measures that will be implemented to minimise erosion and subsequent sediment loss from a site as a result of soil disturbing activities which, in this case is the riparian area earthworks and the riverbed excavation.

As a minimum, an ESCP will be required to include the following:

- Site Plan
- Project Description
- Sediment Yield Calculations / Risk Assessment
- Erosion and Sediment Control Principles and how these will be given effect to
- Design of Erosion and Sediment Controls with supporting calculations
- Timeline and sequencing of works
- Maintenance and Monitoring / Reporting
- Heavy Rainfall Response
- Procedures for review
- Responsibilities.

The overall expectations of an ESCP incorporates the best practical option for undertaking the works in a way which minimises environmental effects, good site management (non-structural practices and behaviours e.g., staging construction and minimising disturbance), and applying discharge standards where applicable.

Spill Prevention and Response Plan

The purpose of a spill prevention and response plan is to specify how the site will avoid, manage and contain accidental spills of fuel, transmission fluid, oils, or any other hazardous substances.

The spill prevention and response plan will be required to detail how to safely identify and contain hazardous substances spills, procedures for cleaning up and disposing of contaminated material and reporting of spills. There are typically three parts to a spill prevention and response plan:

1. An assessment on the risk of spills. In this instance, it is expected that the hazardous substances that will need to be managed are limited to machinery fuel and fluids. The proposed construction works do not require the use of hazardous substances.
    i. List of chemical/substances that will be used including inventory sheets required to keep track of materials, and ensure all containers are clearly labelled.
    ii. Up to date Material Safety Data Sheets (MSDS) to be available at all times if substances requiring MSDS are to be used on site.
    iii. Identification of the areas that could be affected by a spill.
2. Plans to reduce the risk of a spill.
    i. For Fuels and Oils
        - Refuelling of mobile plant is to be done outside of the river bed and outside of an area where spills may readily drain to the river bed. Refuelling to be undertaken on an impermeable base, however if this is not possible a drip try must be used.
        - For non-mobile plant, refuelling must be done with a drip try or other spill containment installed.
        - Conduct regular maintenance checks on all vehicles and machinery to minimise the chances of fuel or oil leaks or hose blow outs.
        - Have a spill kit available on site, which can be used to contain and clean up spills of chemicals, fuels and other hazardous substances. A spill kit contains equipment used to clean up a spill such as a shovel, broom, drain covers, sandbags, booms and absorbent material. All spills need to be handled with compatible materials. The kit should also contain equipment for storing and disposing of spilled material such as safe containers, bags, and drums.
3. A response plan for hazardous substances spills. This section needs to cover how the following steps will be implemented:
    i. Health and Safety e.g., correct personal protection equipment to be wearing.
    ii. Identification of the substance spilt.
    iii. Stop the spill.
    iv. Contain the spilt material.
    v. Notify Regional Council / pollution hotline.
    vi. Dispose of contaminated material.
    vii. Record and report details of the incident.
    viii. Restock the spill kit.
    ix. Review the incident and see how the incident could be avoiding in the future.

Fish Management Plan

Due to works taking place within the bed of the Ohau River, the activity has the potential to kill or injure fish. Therefore, a Fish Management Plan (FMP) is required to address and mitigate this effect. The purpose of the FMP is to set out a plan to avoid and/or mitigate the effects of the construction works on the fish within the bed of the river.

The FMP will need to specify the methodology by which the impact area within the channel will be isolated and how the fish in this reach will be captured and relocated before the flow within the impact reach is diverted and excavation begins.

The Ecological Assessment of a proposed intake structure of the Poads Road Reservoir, Levin by Wildlands dated January 2023 has assessed the feasibility of fish relocation and notes that the wadeable depth of the river within the

impact reach indicates that intensive electric fishing is likely to be the most effective method to capture the resident fish in this area. Because of the size of the channel, it is likely that two teams, each with an electric fishing machine, will need to undertake multiple passes through this reach to capture and relocate all of the fish present.

Therefore, the FMP will specifically include the methodology of the above, including, isolating the working area, capturing and relocation of the fish, and how fish passage will be provided in the bed of the water body for the duration of the activity.

The FMP will also identify notification required to mana whenua prior to the works being undertaken and provide the opportunity for mana whenua involvement in the fish recovery and relocation process. Further, the FMP will identify any other statutory or regularly approvals required and ensure protocols are in place for these approvals to be obtained prior to the works commencing.

As noted above, fish relocation – undertaken in the same manner as above – will also be required prior to ceasing flow to the temporary diversion channel upon completion of the intake works.

Riparian Planting Plan

Due to the works requiring the removal of riparian vegetation along the left bank of the Ohau River, a riparian planting programme to replace some of the vegetation removed with suitable indigenous species will be implemented.

The Damwatch Feasibility Design Report dated March 2023 outlines that following the completion of works, the site will be restored as follows:

a. The banks and riparian margins left in a stable condition and revegetated with preference to native woody vegetation.

b. All exposed earthworks rehabilitated with native plants.

Therefore, the riparian planting plan will address the above and include where to put fences, what plant species to plant, where to plant, and how the area will be maintained. The riparian planting plan will be developed in consultation with mana whenua to ensure selection of appropriate species.

Flood Contingency Plan

During construction, the main channel will be diverted to a temporary channel within the river corridor which will be designed to ensure it has sufficient capacity to manage expected diverted flows. However, if a large flood event occurs during the construction period, it is expected that this will be conveyed via the diversion channel and the area where construction is occurring. Construction does not require significant material and equipment to be located within the riverbed works area while the site is being actively worked on. A Flood Contingency Plan will be developed as part of the overall suite of construction management plans and will include provisions for monitoring long term weather forecasts and for exiting the construction area and removal of all machinery in the event of anticipated or forecast flood flows. This will include making use of the Horizons Regional Council River Alert System and regular communications with the Horizons River Management Team. The Flood Contingency Plan will ensure that materials which may be in the river bed which could pose a potential downstream risk can be removed from the river bed prior to the flood event. The construction period for the in-river works is relatively short being 1-2 months and therefore these measures will be able to be easily implemented and reflect standard best practice construction methodology.

Certification of Managements Plans

All of the above management plans will be provided to Horizons Regional Council for technical certification purposes at least 20 working days prior to the planned commencement of in-river and riparian works. As discussed above, it is recommended that the consent conditions provide for the various management plans to be submitted as a single Integrated Construction Management Plan.

Pipe Bridge

The construction of the pipe bridge has the potential to have temporary construction effects, given that it is to be installed within and nearby to the bed of the river. The scale of these effects is significantly lesser than those of the construction of the intake structure and these are able to be managed appropriately by way of construction methodology and management plan that follows the best practice principles for works in and near waterways as set out in detail above, and particularly avoiding works in the bed where possible and avoiding any unnecessary discharge of sediment during construction. An Integrated Catchment Management Plan for this aspect of the project in a similar manner to that described above (noting that the scale of effects to be managed will be significantly less than the intake in-river works) is recommended.

Appendix J

EROSION AND SEDIMENT CONTROL PLAN

Horowhenua District Council Poads Road Water Supply Reservoir

Erosion and Sediment Control Plan



Final 9th July 2024

Ridley Dunphy Environmental Limited

Document title: Erosion and Sediment Control Plan

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Prepared by: Graeme Ridley, RDE Limited

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Quality Assurance Statement			
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Revision schedule		
Rev. Number	**Date**	**Description**
1.0	13th June 2024	Draft for RDE site visit
2.0	5th July 2024	Draft for client and RDE review
3.0	9th July 2024	Final for consenting

Glossary of terms

Report relevant terms	Definition
Earthworks	The disturbance of land surfaces by blading, contouring, ripping, moving, removing, placing or replacing soil or earth, or by excavation, or by cutting or filling operations.
Erosion control	Methods to prevent or minimise sediment generation, in order to minimise the adverse effects that land disturbing activities may have on a receiving environment.
Flocculation	The process whereby fine particles suspended in the water column clump together and settle. Flocculation can be used to promote rapid settling in sediment retention ponds by the addition of flocculating chemicals (flocculants).
Land disturbing activity	Any disturbance to the ground surface that may result in soil erosion through the action of wind or water.
Sediment control	Capturing sediment that has been eroded and entrained in overland flow before it enters the receiving environment.
Sediment delivery ratio	The proportion of the sediment eroded from within a catchment area that actually reaches sediment treatment controls.
Sediment generation	That sediment that is generated on the site of earthwork activity prior to treatment through any sediment retention device.
Sediment load	Mass of sediment carried in suspension within rivers and marine waters.
Sediment retention pond	A detention structure that is used during the construction phase of earthworks activity to treat any sediment laden runoff and retain sediment.
Sediment yield	That sediment which leaves the sediment retention devices and enters the receiving environment can be expressed in many ways including suspended sediment concentration or a mass load on a time basis or an aerial basis.
Stabilisation	An area inherently resistant to erosion such as rock, or rendered resistant by the application of aggregate, geotextile, vegetation, mulch or an approved alternative. Where vegetation is to be used on a surface that is not otherwise resistant to erosion, the surface is considered stabilised once an 80% vegetation cover has been established.

Glossary of abbreviations

Report relevant abbreviations	Definition
BPO	Best practicable option
DEB	Decanting earth bund
ESC	Erosion and sediment control
ESCP	Erosion and sediment control plan
GWRC Guidelines	Erosion and Sediment Control Guide for Land Disturbing Activities in the Wellington region. Revision 1 dated February 2021.
SESCP	Specific erosion and sediment control plan
SF	Silt fence
SRP	Sediment retention pond
SSF	Super silt fence

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1. Introduction

1.1 Purpose and scope of this report

This Erosion and Sediment Control Plan (ESCP) is prepared in support of a proposed water supply reservoir referred to as the Levin Water Supply Water Harvesting and Resilience Project (the "Project"). Section 1.3 below confirms the Project location and extent which includes construction of a reservoir, spillway, realignment of Poads Road, intake structure, riparian vegetation clearance and ancillary earthworks top support the overall Project. Approximately 800,000m^3 of earthworks are expected to occur (majority in the reservoir itself) over an area of approximately 10ha. Appendix A of this ESCP provides a general layout plan of the Project.

This ESCP supports these earthworks and confirms the overall approach to erosion and sediment control (ESC) during the construction phase.

1.2 Erosion and sediment control and SESCP development process

Our assessment of the ESC and practices likely to be required for the Project is based on the detail within this ESCP. This ESCP outlines the principles that will need to be applied throughout the adopted approach for all construction activities and associated water management.

Further detailed analysis will occur prior to earthworks and stream works commencing at a given location and a Specific Erosion and Sediment Control Plan (SESCP) will be developed in these specific locations or for specific activities. The SESCP will consider the specific environmental and ecological values and will then determine the most effective and appropriate form of construction water management practices required to manage on a site-by-site basis, during the construction period. The process of this SESCP development is illustrated in Figure One below.

These SESCP's will be submitted to the Horizons Regional Council (Horizons) for certification against the consent conditions, this ESCP and best practice. The SESCPs will be informed by the principles of this ESCP and will enable specific construction constraints and opportunities to be incorporated into the specific design for the works at that location. The SESCPs will also allow for enhanced outcomes and the opportunity for implementing improved practices based on new knowledge and outcomes. SESCPs will include the following detail:

- Work / activity details;
- Location of the work;
- Contour information;
- Risk identification level and management and measures to reduce this risk;

- Erosion and sediment control location, design and supporting calculations;
- Chemical treatment design and details;
- Catchment boundaries;
- Details of construction methods;
- Contingency measures;
- Design details;
- A programme for managing non-stabilised areas;
- The identification staff who will manage all controls;
- The identification of staff who monitor compliance with conditions;
- A chain of responsibility for managing environmental issues;
- Methods and procedures for decommissioning measures; and
- Design details for managing the discharge of contaminants

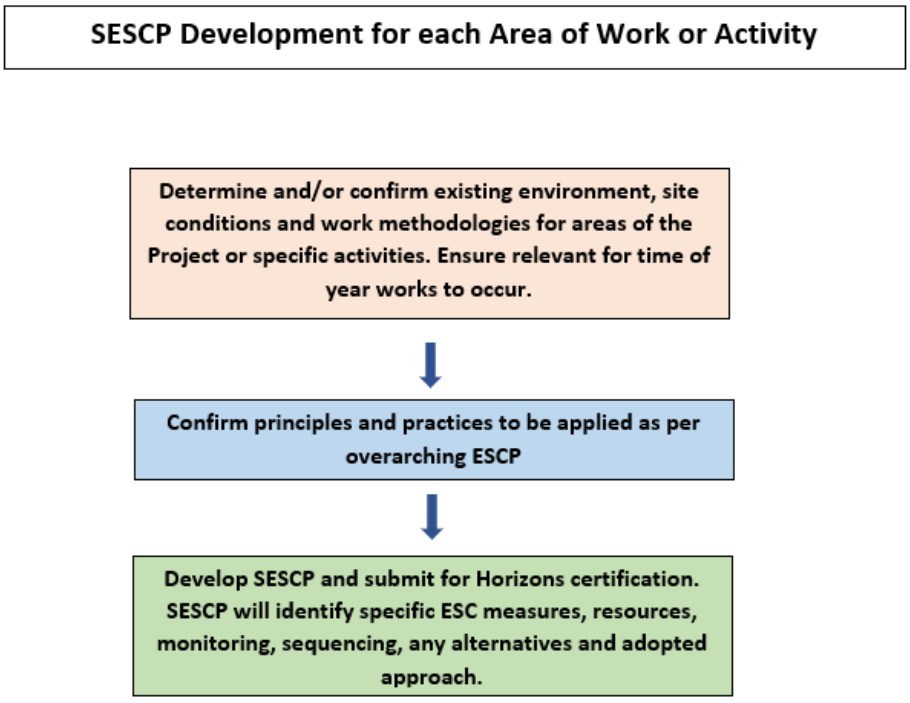


Figure One: The SESCP Development Process

1.3 Project description and features

The Project is located on Poads Road on a river terrace between Poads Road and the Ohau River, approximately six kilometres southeast of Levin (Figure Two). Water is to be provided to the reservoir from the Ohau River via a new intake structure.

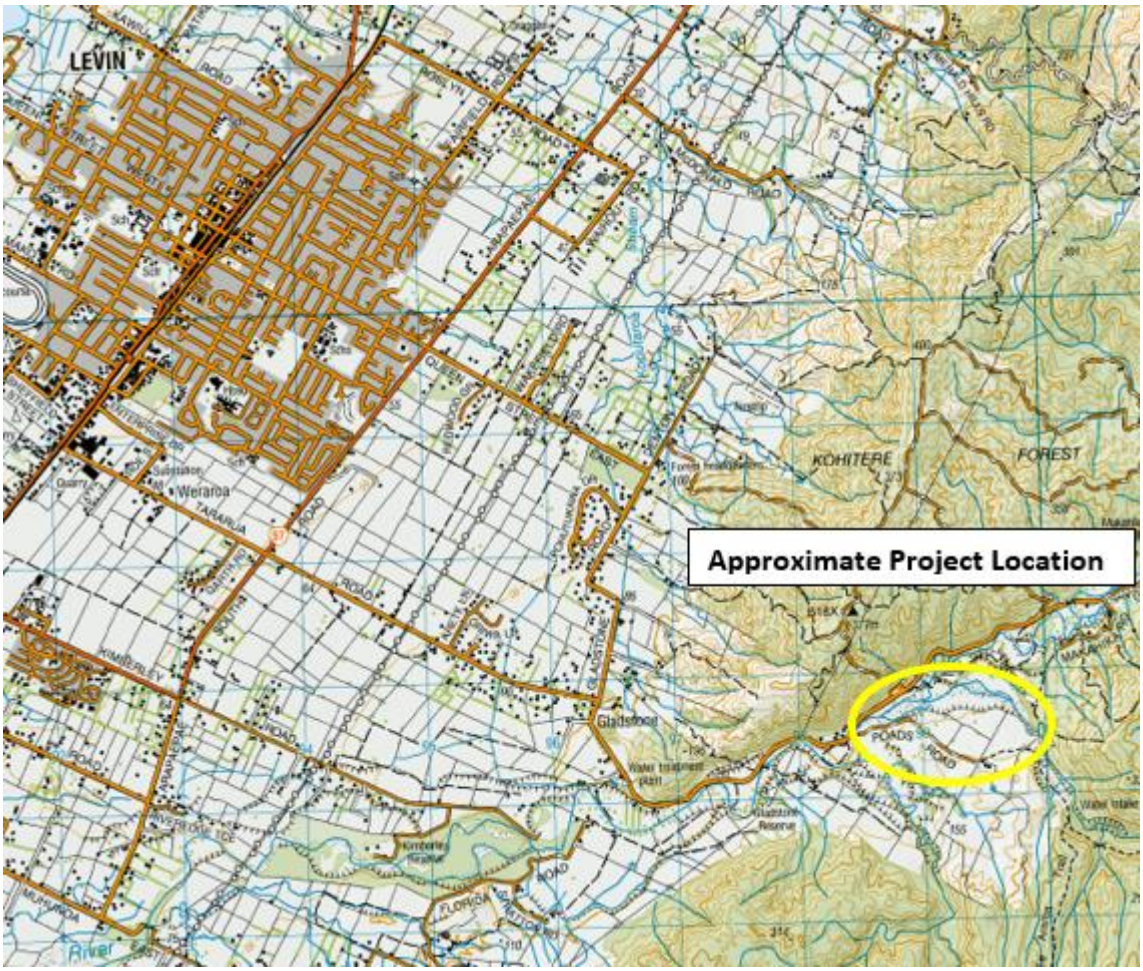


Figure Two: Project Location

A site visit to assess the ESC options occurred on the 14th June 2024 and this allowed an overview of the site conditions and the Project footprint. The Project itself is located on a terrace above the Ohau River which flows to the west and eventually discharges into the west coast south of Levin.

Key site observations of importance to this ESCP included:

- The main Project site is relatively flat with a fall from the southeast to the northwest.
- The current ground surface of the main Project area was observed to be an area of an alluvial terrace underlain by gravels and older alluvium which had evidence of silty clay substrate in some locations. These sediments are described as poorly sorted to well sorted gravels
- The flood plain extent is limited to immediately next to the Ohau River channel with the Project on the true left bank of the Ohau River upstream of the constriction at the Poads Road bridge and upstream of the confluence with the Makahika Stream. The Horowhenua District Council flood risk map suggests in flood events water backs up from the Poads Road bridge into the wide section of flood plain opposite the Project site. A nominal flood water level of 118 m RL is confirmed, and this corresponds to the same level as the northwestern extent of the reservoir site. Flood mapping from Horizons confirms this flood plain extent which is evident on site.
- The intake structure is to be placed within the Ohau River itself. This requires a diversion of river flows around the area of works while the structure is installed. The Ohau River was observed to have good water quality during the site visit. This intake structure is located within the identified flood area.
- While it is hoped that the Project can be completed over summer earthwork seasons there is a possibility that winter works will be required with this ESCP including such activity. The intake structure will however be restricted to a summer operation.

1.4 Project construction details

1.4.1 Reservoir Site

The reservoir embankment includes broad upstream and downstream shoulders of bulk fill, a central filter and chimney drain. The crest width is six metres, providing suitable access to the crest. The upstream slope is overlain by a geomembrane liner system. The surface of the geomembrane liner is protected by riprap across the base of the reservoir and near the embankment crest.

The process involves topsoil materials to be stripped from beneath the footprint during construction. The design assumes that the embankment bulk fill will be sourced from excavation within the reservoir site itself consisting of alluvium terrace and older alluvium. Excavation depths increase towards the reservoir's southern end, which follows two sloped terraces. The potential excavation depths vary between 3 m to 12 m within the reservoir's footprint.

Some processing of granular materials may be required and would likely require an area in the land immediately to the north of site. This would include some potential stockpile storage.

Most of the construction is likely to occur in summer periods which will minimise sediment generation however dust management will remain a key consideration. The earthwork activity involves the removal of approximately 800,000m^3 of surplus material which will be removed from the site to another approved infrastructure project and/or to an approved cleanfill site. This volume is the maximum / conservative volume that would be taken off site through the Project duration with some of the material to be used within the Project embankments and footprint.

On completion of earthworks the liner system is to be installed across the full extent of the reservoir. This consists of an HDPE low permeability geomembrane with adequate protection by geosynthetic geotextiles. In addition, across the base (under the liner) there is a groundwater collection layer of granular drainage materials and HDPE collection pipes embedded within it.

The specific requirements for the systems and procedures for the reservoir design will be defined at the detailed design stage and any implications or relevant details for environmental management will also be defined and detailed within the SESCP process.

1.4.2 Intake Structure

The intake structure is approximately 27m wide and 90m long and will be installed in the following manner. This will be confirmed through the detailed design process and further confirmed through the SESCP process as per Section 1.2 above.

1. Construction of a channel to divert the river flow away from the intake construction footprint. Construction works are to be undertaken in low flow seasons to reduce river levels. Fish spawning and migration periods will be avoided where practicable and will be managed under a Fish Management Plan to be prepared separately.

2. Depending on anticipated river flows and natural groundwater levels, construction of further barriers may be required, such as bunds and supplemented by temporary sumps and pumps to intercept groundwater flow entering the excavation. These temporary sumps and pumps in the isolated riverbed would likely be installed at low points at the edge of the proposed infiltration gallery footprint and would be dewatered based on the dewatering methodologies detailed within Section 5.3.2 below.

3. The infiltration gallery area will be excavated by suitable plant to the design level below the riverbed.

    - Larger material encountered in the riverbed will be stockpiled for later use on the riverbed surface of the completed infiltration gallery.

- Permeable gravel drainage material will be placed to the design thickness inside gabion basket type structures, and compacted to appropriate standards in the gallery footprint.

- Perforated pipes and backwash pipework will be placed in drainage material so that it surrounds and covers the pipework in the gabion basket.

- Stockpiled material will be placed over the permeable gravel layer to provide an armouring to the riverbed and riverbanks to inhibit general riverbed scour.

4. Shallow trenches from the infiltration pipework to the sedimentation sumps will be excavated and pipes installed to join the infiltration galleries to the sumps. Pipework will be installed with suitable drainage material surround.

5. The sedimentation sump and submersible pump sump will be constructed in the nearest river terrace by a suitable excavator, either by trenching in from the riverbank or excavation from ground surface. The approach is still to be assessed and determined with this ESCP addressing both potential methodologies.

6. Upon completion of the river works all diversion features and equipment will be removed and the riverbed restored. This includes undertaking these works in accordance with the Fish Management Plan.

Importantly it is anticipated that machinery working in the Ohau River, in accordance with approved method statements, will be sprayed down and washed prior to river entry in a suitable bunded location, to minimise and avoid the spread of freshwater plant and animal pests, and discharge of contaminants. Fuels and other chemicals for plant will be stored away from the waterways and above the anticipated flood levels.

The period required to complete the works is dependent on the weather conditions at the time of undertaking the works. The expected construction period for the river works and civil works in the riparian zone is less than 2 months. As far as possible, this will be planned to occur during periods of settled weather.

1.5 ESCP content and project specific construction activities

As part of the development of this ESCP consideration has been given to Horizons' expectations with respect to the erosion and sediment control plan content. This ESCP therefore has been developed with consideration of the following detail:

a. Details of all principles, procedures and practices that will be implemented to undertake erosion and sediment control to minimise the potential for sediment discharge from the site;

b. The design criteria, supporting calculations, dimensions and contributing catchments of all key erosion and sediment control structures, including (but not limited to) diversion bunds/channels and decanting structures;

c. A site contour plan of a suitable scale to identify;

   i. The locations of waterways;

   ii. The extent of soil disturbance and vegetation removal;

   iii. Any "no go" and/or buffer areas to be maintained undisturbed adjacent to watercourses;

   iv. Locations of stockpiles;

   v. All key erosion and sediment control structures;

   vi. The boundaries and area of catchments contributing to all erosion and sediment control devices;

   vii. The locations of all specific points of discharge to the environment; and

   viii. Any other relevant site information.

d. Construction timetable for the erosion and sediment control works and the earthworks proposed;

e. Timetable and nature of progressive site rehabilitation and re-vegetation proposed;

f. Maintenance, monitoring and reporting procedures;

g. Rainfall response and contingency measures including procedures to minimise adverse effects in the event of extreme rainfall events and/or the failure of any key erosion and sediment control structures;

h. Procedures and timing for review and/or amendment to the ESCP; and

i. Identification and contact details of personnel responsible for the operation and maintenance of all key erosion and sediment control structures.

This ESCP is prepared on the basis that once granted the consent will contain a condition that requires a SESCP to be established as per Section 1.2 above. This is accepted as best practice and the SESCP can be established with the successful contractor at that time to ensure flexibility and best practice and innovation can be implemented accordingly.

1.6 Roles and responsibilities

As the consent holder, Horowhenua District Council will have the overall responsibility for meeting the requirements of this ESCP. The contractor engaged will include an environmental manager (or equivalent) that will implement the ESCP (and the SESCP) including all required monitoring, management and necessary communication to the regulatory agencies.

This ESCP will be implemented for the duration of the construction works and a copy of this ESCP and all SESCPs will be kept in an accessible location for the duration of the Project.

Specific roles and responsibilities including contact details for key staff with environmental responsibilities will be identified within the SESCPs as necessary.

2. Non-statutory context and technical guideline framework

Horizons have recently adopted the *Erosion and Sediment Control Guide for Land Disturbing Activities in the Wellington Region February 2021* (GWRC Guidelines) as a best practice guide for land disturbing activities. These GWRC Guidelines incorporate Auckland Council's GDO5 (GD05) as a minimum standard for designing erosion and sediment controls and development of an associated erosion and sediment control plan as part of resource consent and permitted activities for earthwork sites.

As part of the ESC assessment for this Project we have assessed the GWRC Guidelines and New Zealand Transport Agency Erosion and Sediment Control Guidelines (NZTA Guideline). The principles as outlined within each of these guidelines is essentially the same and will be adopted by this Project. The practices are also similar however some fundamental differences are noted with design criteria.

For this Project we have adopted a best practice approach which reflects the current state of knowledge (as per the guidelines above), the specific physical conditions to be encountered on the site and the previous knowledge of the team (from other similar projects) which will be reflected in the measures adopted. Where there is any uncertainty as to the specific design to be implemented, the GWRC Guidelines will take precedence.

3. Existing environment

3.1 Rainfall

Levin experiences approximately 1370mm rainfall per year, with the months of April through to October typically a wetter period of the year. Figure Three below illustrates this rainfall pattern which is assessed to be similar for the Project site.

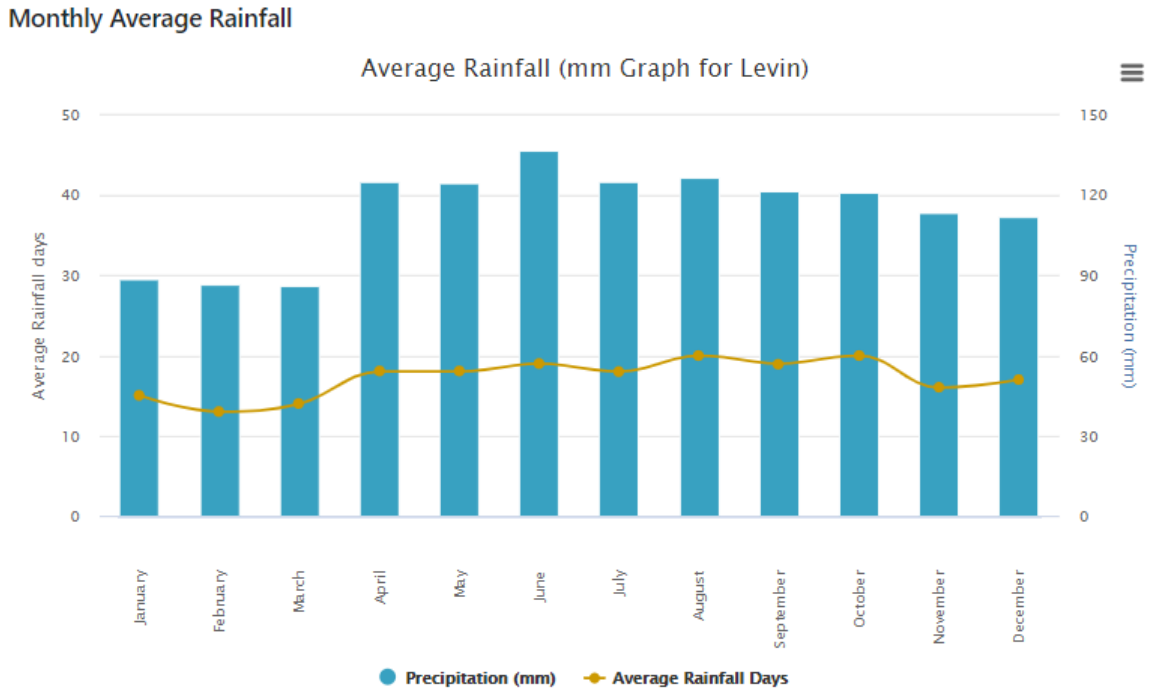


Figure Three: Levin Annual Rainfall Patterns

3.2 Geology

The geotechnical investigation work that was undertaken in support of the Project confirms that three general soil units were encountered in the test pits and boreholes and are described as:

- Topsoil which occurs across the site and is about 0.2 to 0.4m thick.
- Terrace alluvium which underlies the topsoil and extends 5.5 to 19.0 m below ground level The test pits confirmed that gravel typically dominated the alluvium samples however, fine particles were also encountered.
- Older alluvium was encountered below the terrace alluvium and is possibly of estuarine origin. This is not expected to be encountered through the Project.

3.3 Groundwater

The groundwater catchment to the site is to the south of Poads Road and extends for the length of the reservoir excavation. It is assumed that the groundwater catchment crest coincides with the surface water catchment and that the horizontal permeability is greater than the vertical permeability.

The groundwater levels are expected to vary throughout the year and the annual average groundwater yield calculated along the southern face of the excavation for the reservoir is estimated to be 34 m^3/day. Monthly groundwater yields are estimated as set out below:

Month	Daily groundwater discharge (m^3/day)
Jan	24.6
Feb	30.2
Mar	40.6
Apr	29.5
May	32.0
Jun	40.6
Jul	37.7
Aug	32.4
Sep	35.2
Oct	39.5
Nov	35.2
Dec	37.0

Table One: Groundwater volume daily estimate

To the north of the Project area on the lower terrace a vegetated channel was observed on site, and this is expected to be the location where some groundwater discharge will be observed at certain times of the year. This discharges directly into the Ohau River and is illustrated in Figure Four below.



Figure Four: Lower terrace channel

3.4 Water quality

No specific baseline water quality monitoring has been undertaken for the Project however both the Ohau River is recognised regionally as having a good water quality with some contamination typical of rural rivers with stream bank and bed erosion. Horizons report that the Ohau River is important recreationally and also contains ecological value. Horizons further note the efforts being made within the catchment associated with:

- Fencing of river systems so stock do not get into water and create contamination;
- Assisting rural properties with erosion control from hill country areas;
- Ensuring any waste that enters the stream and river systems is properly treated to meet water quality standards; and
- Monitoring water takes from the Ohau River to ensure adequate water allocation.

The Project reservoir site also has an identified 'marginal' very small highly degraded wetland. This is discussed and assessed within the Wetland Delineation Report however it is noted that the conclusion is that the restoration of the wetland areas on the lower floodplain of the Ohau River would easily mitigate the loss of the wetland values within the reservoir itself.

3.5 Flooding

Flood modelling and/or historic data for the area is limited; however, Horizons have confirmed that some flooding is associated with the general Project location due to the river systems. Horizons provided the Figure below which illustrates the full channel flood extent and also an indicative flooding extent. This confirms that the reservoir site is outside of the flood risk however the intake structure is within this higher risk location.

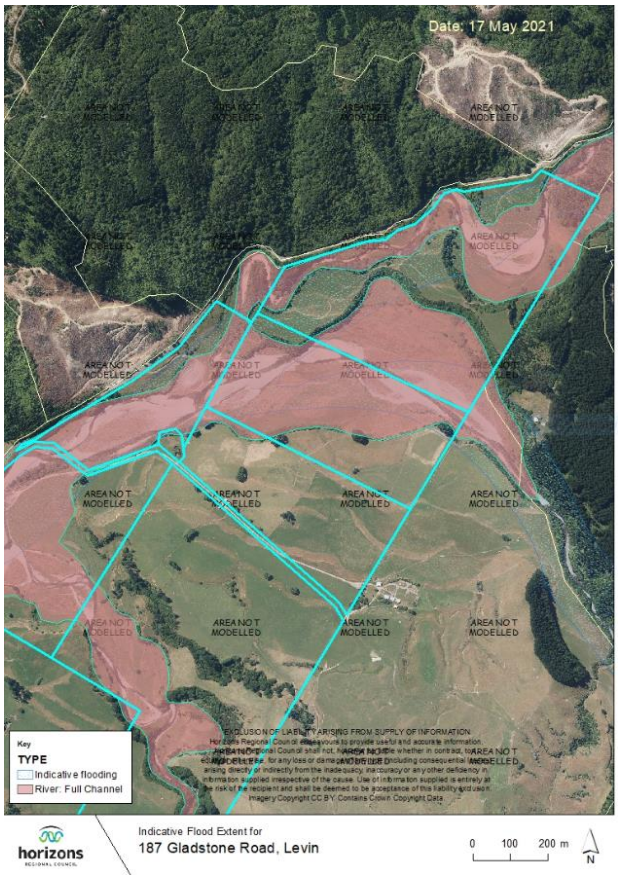


Figure Five: Project Flood Information

3.6 Overall sensitivity of the receiving environment

Based on the knowledge of the receiving environment and the extent of the Project works it is important that the minimisation of discharges from construction activity occurs at all times. Best practice measures will need to be designed, implemented and maintained to ensure this can be achieved overall.

3.7 Magnitude of effects

Table Two below provides a description of the assessment criteria and associated magnitude that is utilised to assess and confirm the level of effect as detailed within this ESCP.

Magnitude		**Description**
Significant	Very High	Total loss or very major alteration to key elements/features of the baseline conditions such that the post development character/composition/attributes will be fundamentally changed and may be lost from the site altogether.
	High	Major loss or major alteration to key elements/features of the baseline (pre-development) conditions such that post development character/composition/attributes will be fundamentally changed.
Moderate		Loss or alteration to one or more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed.
Minor		Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns.
Negligible		Very slight change from baseline condition. Change barely distinguishable, approximating to the 'no change' situation.

Table Two: Criteria for describing impact magnitude

4. Erosion and sediment control principles

This section outlines the general principles for construction water management control on the Project. The receiving environment associated with the Project area includes the freshwater Ohau River system which is sensitive to sediment discharges and deposition.

It is essential that construction water management measures and practices implemented during the construction phase of the Project recognise the receiving environment values and manage the discharge, particularly sediment. Higher risk areas are also identified as those locations within, adjacent to, or directly connected to, freshwater environments in particular the inlet structure.

This ESCP provides the background and assesses the erosion and sedimentation effects that will result from Project construction activity.

The development of the ESC measures discussed in this ESCP is based on:

- Minimising the potential adverse effects on the receiving environment, by using measures, both structural and non-structural that meet or exceed industry best practice and GWRC Guidelines;
- Developing SESCPs and undertaking pre-construction meetings for specific stages of construction and having regular 'toolbox' meetings onsite with relevant personnel, including Horizons, in attendance as part of the construction phase;
- Ensuring that all construction water discharges are considered and assessed as part of the Project implementation;
- Maintaining a register of control measures and 'As Built' information of key controls such as clean water diversions (CWDs), dirty water diversions (DWDs) and sediment retention ponds (SRPs) to allow for quick and efficient referencing, identification and understanding of function and location of the various measures installed onsite;
- Ensuring that all ESC measures utilised are structurally sound and have appropriate geotechnical approval where necessary; and
- The development of an adaptive monitoring (continuous improvement) programme, to inform the extent and environmental performance of construction activity onsite and directing the work activity to influence and reduce the discharge of sediment into the receiving environment.

The design criteria as detailed below incorporate some procedures and measures that exceed the guidance provided in the GWRC Guideline. Through the design and construction phases of the Project, we recognise that there will be scope for innovation and alternative means of achieving the same environmental outcome as specified in consent conditions. The implementation of SESCPs

will allow for this further innovation, flexibility and practicality of approach to construction-related water management and in doing so will allow the construction of the Project to continually adapt to changing construction and climatic conditions.

In addition, the Project will adopt a set of key principles that apply to all earthwork activities and the development of SESCPs. These principles have informed the development of the specific principles for this Project and will further be reflected in the SESCPs. Appendix B of this ESCP contains the principles as reflected within the GWRC Guidelines.

4.1 Construction water management principles

1. All construction works will be undertaken in accordance with the best methods and practice available at the time of construction to:

    - Minimise the volume and area of the proposed earthworks required for the Project through the Project design matching expected soil types, geology and risk while meeting the Project delivery requirements;

    - Minimise the potential for sediment generation (erosion) and therefore resultant sediment discharges while maximising the effectiveness of erosion and sediment control measures associated with earthworks;

    - Manage all non-sediment contaminants with best practice methodologies at all times; and

    - Take all reasonable steps to avoid or minimise potential adverse effects on water environments within or beyond the Project works boundary, with particular regard to reducing opportunities for sediment generation and discharge of non-sediment contaminants.

2. Construction water management measures will be based on a range of structural (physical measures) and non-structural (methodologies and construction sequencing) measures, and where practicable, be undertaken and implemented with full consideration of the following:

    - **Prevention:** Excluding clean water runoff from entering the active work areas, therefore preventing clean water runoff from combining with excavated soil and/or construction material. Requiring the use of CWD channels and/or bunds to divert runoff from the upstream side of the work area.

    - **Capture:** Any sediment laden runoff generated within the working area will be captured through the use of DWD channels and/or bunds on the downstream side of the construction site, which will direct sediment laden runoff from the site to an appropriate sediment control device. Sediment will be captured in one or more

sediment control measures. Any non-sediment contaminants will be captured and treated within purpose-built devices.

- **Minimisation:** Limiting the length of time and the area of exposed / disturbed soil to reduce the erosion potential of an exposed area. Progressive stabilisation of exposed areas will reduce the potential for erosion to occur including those areas exposed but not subject to current works.

- **Staging and Sequencing of Works:** Construction activity will be carried out in stages and works within those stages will be sequenced to manage erosion and sedimentation. Working areas will be progressively stabilised as appropriate as the works progress.

3. Construction water management measures will be outlined in detail in the SESCPs. All erosion and sediment controls will, where practicable, meet the minimum criteria as detailed in this ESCP and will incorporate innovative ideas and procedures to ensure best practice applies and to match the local challenges and opportunities.

4. The development of SESCPs, in accordance with the direction and principles of this ESCP, will allow for future innovation, flexibility and practicality of approach to erosion and sediment control and shall allow the ability to adapt appropriately to changing conditions.

5. Progressive and rapid stabilisation of disturbed areas using mulch, aggregate and geotextiles will be on-going during the construction phase. If other stabilisation alternatives such as polymer/soil binder products are applied they will need to be verified as an appropriate and authorised stabilisation media, demonstrated to have no residual impacts and will need to be trialled on site to demonstrate appropriateness prior to use. Temporary stabilisation will apply particularly with respect to stockpiles, access track batters, ground improvement locations where topsoil is removed and with concentrated flow paths.

   Stabilisation will need to be appropriate to the soil surface geology with the intent of achieving an 80% vegetative cover or non-erodible surface over the entire exposed area of earthworked areas. Stabilisation is designed for both erosion control and dust minimisation and will be progressively implemented, including temporary stabilisation of those areas of earthworks not actively worked for more than a 14-day period.

6. All SRPs will be fitted with floating decants with a mechanism to control (or cease) outflow during dewatering pumping activities to these structures if required. Pumping will be such that pump volumes will only be to the same level as that able to be fully captured within the retention structure and discharged out the designed decant structure.

7. All Project SRPs will be chemically treated with a flocculant appropriate for the soil type and discharge location unless the SESCPs for that location confirms that there are no benefits from such use.

8. Stream works, in particular that associated with the intake structure, will be undertaken in a manner that recognises the higher risk of this activity, from a sediment generation and discharge perspective, and the sensitivity of the receiving environments. Where practical, works with active stream channels, and any associated works with streams will be undertaken in a "dry" environment. This will be based upon diversion of flows around the area of works. Consideration will also be given to peak fish spawning and fish migration periods (if relevant), during which time instream works will be carefully managed.

9. A flood management plan will be developed which will confirm the process to be implemented should a flood warning be received. This will be based on ensuring the area is as practically safe as possible from minimisation of erosion and also ensuring all contaminant generating activities and equipment, such as hydrocarbons, are outside of the flood risk location.

10. A monitoring and management approach which allows continuous improvement in response to monitoring outcomes will be utilised for the construction activity through:

    - A risk assessment within the SESCPs which will act as a tool to help identify construction risk, identify any specific risk management approaches and advise the construction planning and approach to construction water management;

    - Proactive water quality monitoring, both qualitative and quantitative, will occur as part of the Project implementation as a way of assessing the effectiveness of the treatment and allowing for improvements/modifications as the Project works continue; and

    - Qualitative monitoring which will include visual surveys of the discharges and downstream environment. Quantitative monitoring will include some spot sampling and testing of sediment control device discharges for turbidity and also downstream sampling to allow for comparative analysis and associate actions.

5. Overview of erosion and sediment control and design criteria

5.1 Erosion and sediment control guidelines

As outlined in Section 2 of this ESCP, for this Project we have adopted a best practice approach which reflects the current state of knowledge (as per the guidelines referenced), the specific physical conditions to be encountered on the site and the previous knowledge of the team (from other similar projects) which will be reflected in the measures adopted. Where there is uncertainty as to the specific design to be implemented the GWRC Guidelines will take precedence.

5.2 Key erosion control measures and design criteria

In general, the erosion control measures and associated design to be applied to the Project are as follows:

5.2.1 Construction staging and sequencing

The extent of exposed soil and length of time that area is exposed has a direct influence on the sediment generation (erosion) and sediment yield. The Project will minimise this soil exposure and provide the detail within the SESCPs to ensure areas are subject to progressive stabilisation and are not "exposed" and unworked at any time. Staging and sequencing will be a key non-structural element and includes progressive stabilisation as works advance.

Where areas within the Project are not worked for more than a 14-day period they will be stabilised (as per Section 5.2.4 below) to ensure areas are not left exposed for long periods of time and will therefore reduce the potential for sediment generation (and subsequent yields).

5.2.2 Clean and dirty water diversions (CWD and DWD)

CWDs provide for the controlled conveyance of upslope runoff away from works areas and will be used on the Project to prevent water from the undisturbed catchment above the works from entering the construction area.

CWDs will be designed to cater for the 20-year ARI rain event with a 1-hour duration (plus a 300mm freeboard). This design is consistent with best practice and will ensure that the works are sufficiently protected from flows from the natural catchment outside of the works. CWDs will be stabilised with either vegetation or geotextile cloth. For the reservoir site an existing CWD is in place and will form the basis of the CWD from the eastern catchment for those works.

DWDs transfer sediment laden water to sediment retention devices for treatment. They are effectively a conveyance device and are designed to cater for the 20-year ARI rain event with a 1-hour duration (plus a 300mm freeboard). The DWD design criteria for the Project will ensure that

all construction runoff from rain events up to the 20-year ARI event will be transferred to treatment devices. This design (including the freeboard provision) effectively has the same capacity as a 100-year rainfall event and therefore is assessed as providing a robust and best practice approach.

DWDs will be stabilised dependent upon soil type and slope for the specific area of works and will have this detail outlined within the SESCPs.

A maintenance programme will be implemented during Project construction activity to remove any resultant sediment deposited within the DWD. The DWD will also have drop out pits with a $2m^3$ volume capacity established at 50m intervals along the channel itself to assist with the capture of the heavier particle size sediments that are generated.

5.2.3 Contour drains

Contour drains are temporary berms or excavated channels or a combination of the two that are constructed to convey water across a slope at a gradient of maximum 2% slope. They are installed prior to rainfall events to reduce the slope length and therefore the velocity of water flowing down disturbed slopes and hence reduce sediment generation.

Contour drains will be utilised on the Project (in particular pre rain and pre long periods of no works on site) on surfaces to slow velocities of runoff and minimise erosion potential.

5.2.4 Stabilisation for erosion and dust management purposes

Stabilisation is a key element of the Project and will include mulching, vegetative cover, geotextile and the use of hard fill material. Stabilised is defined as:

> *An area inherently resistant to erosion such as rock, or rendered resistant by the application of aggregate, geotextile, vegetation, mulch or an approved alternative. Where vegetation is to be used on a surface that is not otherwise resistant to erosion, the surface is considered stabilised once an 80% vegetation cover has been established.*

Progressive and rapid stabilisation of disturbed areas will be ongoing throughout the Project to achieve the necessary staging and sequencing process. Mulching using hay and/or straw will typically apply to slopes of less than 15 degrees (27%), above which alternatives will need to be considered. The Project contains minimal if any slopes above these criteria. It is acknowledged that the use of traditional mulching can also be prone to wind blow issues making application in these conditions difficult. Therefore, in some circumstances alternatives will be required to be considered.

Stabilisation alternatives include traditional grass sowing methodologies, however this is not considered stabilised until such a time as 80% vegetative cover is established on site. Hardfill with clean aggregate also creates a stabilised surface. If other alternatives, such as polymer/soil binder products or hydromulch products, are to be utilised they will need to be verified as stabilised,

demonstrated to have no residual impacts and will need to be trialled on site to demonstrate appropriateness prior to use.

The development of the SESCPs will determine the specifics of the stabilisation technique and timing.

Stabilisation will be undertaken with three key purposes:

- To achieve the staging and sequencing provisions to reduce sediment generation (erosion potential) of the Project;
- To reduce the open area of higher risk locations to assist with a reduction in sediment generation including wind borne sediment; and
- In response to the adaptive monitoring programme to address any potential effects or undesirable monitoring (water quality) trends.

For the stream diversion associated with the intake structure stabilisation of the temporary stream diversion will be required. The rock-based substrate in this location will likely result in the diversion have a rock lining which in itself will form a clean channel flow path. This will be documented and confirmed within the SESCP. Any exposed soil substrate that results from the stream diversion activity (such as stockpiling of material) will be stabilised using the methodologies as above.

5.2.5 Stabilised construction entranceway

Stabilised construction entranceways are a stabilised pad of aggregate placed on a filter base and are located where construction traffic will exit or enter a construction site. They help to prevent site entry and exit points from becoming a source of sediment and also help to reduce dust generation and disturbance along public roads. In many circumstances on this Project existing stabilised entrances will be utilised. GWRC Guidelines will provide the design criteria.

No vehicles will be allowed to leave the Project site unless tyres are clean and vehicles will not contribute to sediment deposition on public road surfaces. It is currently unknown where the specific construction yard will be established at the Project location, however irrespective of this, stabilised entranceways will be established for all Project entry and exist points.

5.3 Key sediment control measures and design criteria

Sediment control on the Project will involve the treatment of sediment-laden runoff from the various construction areas along the Project. Sediment control will be established through the use of recognised sediment control measures and site management practices.

Sediment control devices will be located outside the 20-year ARI flood level, unless no other viable alternative exists such as those works adjacent to the Ohau River. If sediment control devices are

required within the 20-year ARI flood level, they will be designed to capture only small catchment areas to reduce risk and will be subject to an increased inspection and maintenance regime, in particular the removal of any accumulated sediment.

The sediment control measures to be applied to the Project are as follows:

5.3.1 Sediment retention pond (SRP)

The primary form of treatment of construction runoff from the reservoir site earthworks will be carried out to ensure that sediment is removed to the maximum extent possible from the construction runoff before being discharged to the receiving environment.

Two SRPs are proposed to be established as shown in Appendix C. SRPs will be designed to receive the flows from the upstream earthworks catchment with these limited to a 5ha contributing catchment. It is acknowledged that there may be circumstances where a slightly larger contributing catchment is required to be discharged to these SRPs and this will be detailed within the associated SESCP. In this circumstance an increased monitoring programme, increased forebay volume and the use of baffles will be investigated and confirmed.

It is assessed for this Project that the GWRC Guidelines reflect the most up to date and best practice SRP design criteria and as such this is the default guideline for SRP design. SRPs will be designed with a minimum 3% volume criterion applied in relationship to catchment size (i.e. 300m^3 SRP volume per 10000 m^2 or 1ha of contributing catchment). This criterion will exceed GWRC Guidelines which also allows for the provision of a 2% volume criterion to be applied for some lesser slope sites. The 3% volume criteria provides for a more robust and effective measure. If through implementation SRPs are to be installed and the 3% criteria cannot be achieved this will be detailed within the SESCP with minimum best practice still applying.

SRP spillways will be designed and constructed to ensure that they safely pass the 100-year ARI rain event with low velocity, which will reduce the risk of scour on the downstream side of the spillway. Forebays of SRPs will be established that are designed to capture the majority of the sediment entering the SRP.

We note that as part of the SRP construction, it will be necessary to do the following:

- Check ground conditions and if necessary, undertake a geotechnical assessment, of the proposed SRP site; and
- Remove any unsuitable material and confirm ground conditions as appropriate for SRP establishment.

This specific detail will be provided within a SESCP. Appendix D of this ESCP provides the supporting SRP calculations.

SRPs will be subject to chemical treatment (as per Section 5.3.4 below) with this detail to be confirmed within the SESCP.

5.3.2 Pumping activities

All SRPs will be fitted with floating decants with a mechanism to control outflow such as a manual decant pulley system or a stop valve to be used during pumping activities to these structures. Wherever possible, gravity flow will be used rather than pumping. If pumping is to occur, due to high water tables, groundwater infiltration or impounded areas, then the pumping rates and volumes to SRPs will be designed for the total pump volume to be fully captured within the retention structure and the decants only allowed to discharge once an acceptable standard of discharge quality can be achieved. This standard is to be based on a visual clarity measurement of 100mm.

While it is expected that the SRPs will be the primary form of treatment a lamella plant operation provides a further option to be utilised. This is illustrated below in Figure Six. This lamella will need to be located in a central location for pumping from the works area when required and will discharge direct to clean, provided the discharge quality is achieved. Chemical treatment within this lamella plant is not expected however if required can be implemented within the plant with a specific chemical treatment management plan to be established prior to implementation.



Figure Six: Lamella plant operation

All pumping will need to be managed with a permit to pump system that records time, duration, inlet turbidity and outlet turbidity for the device to which the water is pumped.

5.3.3 Silt fence (SF) and Super silt fence (SSF)

SF and SSF are fabric fences reinforced with stakes and a chain-link backing (SSF only) to allow a physical barrier to sediment laden flows leaving the area of earthworks. This barrier acts as a detention and filter for these flows to ensure sediment yield is minimised. Their design and placement will be based upon the criteria contained within the NZTA Guidelines. SSFs will be used, instead of SFs, in those areas of work adjacent to, or in the immediate vicinity of watercourses.

As a risk management tool for SSFs, the fabric will be installed with a minimum 200mm of fabric placed upslope at the base of the trench to represent best practice.

The Project will utilise SSF as illustrated within Appendix C in locations around the Ohau River and where flows cannot be diverted to the proposed SRPs.

5.3.4 Flocculation

Flocculation is a chemical treatment method for increasing the retention of suspended solids from construction earthworks runoff in SRPs. Flocculant is added to the construction runoff flowing into a SRP via a rainfall activated or flow activated system, via manual batch dosing or through an inline flocculation delivery system.

The use of flocculation chemicals increases the efficiency of SRPs and reduces the amount of sediment discharged to the receiving environment.

All Project SRPs will be chemically treated with a flocculant appropriate for the soil type and discharge location unless the SESCP for that location confirms such treatment will not benefit the environmental outcomes. It is assessed that with the nature of the soils for the Project that flocculation will be effective, and that Polyaluminium Chloride will be the flocculant utilised. Consent conditions are recommended that will ensure this is confirmed pre any earthworks activity.

In addition to the SRPs it is also assessed that pumping (dewatering) activities can also utilise flocculation as necessary. This will also be based on a chemical treatment management plan and will utilise an in-line flocculant delivery system

5.4 Decommissioning of devices

All erosion and sediment control measures will remain in place until such a time as the catchment contributing to that device is stabilised. Once the contributing catchment is considered stabilised, or other measures are in place as agreed through the SESCPs process, the measure will be decommissioned in consultation with Horizons. The decision process and procedure for this will be outlined within the SESCPs.

5.5 Non-sediment contaminants

Non-sediment contaminants generally consist of products and materials that may directly or indirectly discharge into the receiving environment from based site activity.

Potential non-sediment contaminants used in construction activity on the Project are listed in Table Three below:

Product / work activity	Potential contaminants	Indicator	Non-visible potential contaminants
Adhesives	• Adhesives • Glues • Resins • Epoxy • PVC Cement	Oily sheen or discoloration from some products	• Phenols • Formaldehydes • Asbestos • Benzene and • Naphthalene
Cleaning products	Cleaners, ammonia, lye, caustic sodas, bleaching agents, chromate salts	Discolouration	Acidity / alkalinity
Concrete	Cement	Discolouration	Alkalinity (high pH)
Flocculants	Specific to flocculant used but can include pH and aluminium	Very high clarity	• Aluminium toxicity • pH
Sanitary waste	Portable toilets	Discolouration, sanitary waste	Bacteria, biological oxygen demand, pathogens
Vehicle and equipment use	Equipment operation, maintenance, washing, refuelling	Oil sheen, sediment	Total petroleum, hydrocarbons, coolants, benzene and derivatives

Table Three: Potential non-sediment contaminants

The management of these non-sediment contaminants will be subject to specific best management practice and industry guidelines. The details as to the specific non-sediment contaminants that will be used or the associated volumes are yet to be determined, however Table Four below provides some generic guidance as to the expected management approach of these contaminants for the Project.

Product / work activity	Management approach
Adhesives	• Store materials in an area that is not subject to rainfall contact. • Use adhesives carefully and clean up any spilled material. • Follow MSDS as necessary. • Properly dispose of containers once they are empty.
Cleaning products	• Store materials in an area that is not subject to rainfall contact. • Follow MSDS as necessary. • Use products carefully and clean up any spilled material. • Properly dispose of containers once they are empty.
Concrete	• Concrete truck chutes, pumps and internals should only be washed out into formed concrete wash facilities (impoundment for that purpose), other locations where concrete pours are yet to occur or returned to the batching plant / concrete supply yard where washing facilities will be established. • Unused concrete remaining in trucks shall be returned to the concrete batching plant. • Hand tools should only be washed out into the formed areas.
Flocculants	• Ensure the use of flocculants follows an approved chemical treatment management plan and industry best practice. • Follow MSDS as necessary. • Regularly measure pH of the discharge from sediment retention devices.
Sanitary waste	• Avoid knocking over portable toilets. • Place portable toilets away from site vehicle movement areas. • Service portable toilets regularly and empty portable toilets before they are moved.

Product / work activity	Management approach
Vehicle and equipment use	• Fuel storage tanks shall be bunded to store a minimum of 100% of the tank's capacity. Note that for this Project no bulk fuel storage is expected, and mobile refuelling will occur. • Procedures and practices shall be put in place to minimise or eliminate the discharge of lubricants, coolants or hydraulic fluids to the receiving environment. • Have spill prevention and control measures (spill kits) and procedures in place.

Table Four: Potential non-sediment contaminants – management approach

6. Management of construction activities

6.1 Construction activity specific methodology

Appendix C of this ESCP provides the conceptual ESCP approach and plans that will be implemented on the Project. These are discussed below.

6.1.1 Enabling works and bulk earthworks

Enabling works for the Project will likely include further geotechnical investigation, access track establishment and establishment of sediment control devices in particular the SRPs. All enabling works will still be subject to ESC implementation prior to the specific works undertaken. In particular establishment of SRPs will require the installation of a silt fence below the SRP works footprint to capture and treat any runoff during the earthworks phase. Enabling works will also be subject to a SESCP which can detail the proposed measures to be implemented.

Bulk earthworks activity for the reservoir will be undertaken by the contractor based on the methodologies adopted by them at that time. The key concepts remain however whereby the ESC controls will be established first, bulk earthworks will occur and progressive stabilisation will be ongoing.

The specific ESC measures will all be confirmed within SESCPs however will be based on establishment of SRPs outside but downstream of the earthworks cut location and will allow the full catchment of earthworks to flow to these devices. These will be designed to have a contributing catchment of a maximum 5ha each however this will also be confirmed within the SESCPs and may extend beyond this catchment as per Section 5.3.1 above.

These SRPs, in particular SRP #1, will be positioned such that any stockpile material located to the northwest of the reservoir site can also be treated through the SRP device.

The SRPs will remain through to the end of the construction period at which time they can be removed. This decommissioning will follow the process as outlined in Section 5.4 above but will be dependent upon the placement of the reservoir liner and achieving a stabilised surface.

Appendix D of this ESCP provides the supporting calculations for the SRPs.

As part of the bulk earthworks activity the area of excavation will be isolated by CWDs with the existing clean water channel on the southeastern extent of the reservoir to remain in place. This will be extended to the south to capture all upstream catchment and is shown in Figure Seven below.



Figure Seven: Existing clean water diversion

Poads Road will be realigned as a separate activity as shown in Appendix A. This will be managed through the provision of a SSF to be installed as shown. In addition, during the reservoir bulk earthworks activity the existing water table culvert under Poads Road will be blocked and any offsite water will be directed to the west away from the construction activity.

6.1.2 Spillway and river access establishment

This activity is also illustrated in Appendix C.

The spillway extends to the east of the reservoir and will encompass the existing CWD established for the bulk earthworks activity. As a result, a new CWD will be established as shown in Appendix C.

The spillway establishment and associated earthworks will all discharge back into the reservoir location and can be pumped to the existing SRPs previously established. The permit to pump process will apply as per Section 5.3.2 above.

Access to the Ohau River lower terrace and intake structure will be undertaken with the provision of a SSF to be established below the works area. Cut and cover will also apply at all times and as soon as the appropriate grade and levels are achieved a clean aggregate surface will be placed.

6.1.3 Intake construction

The establishment of the intake structure is described above in Section 1.4.2.

The intake structure has an estimate construction duration of 2 months and to achieve the necessary works a full river diversion is assessed as necessary. This will include excavation of a diversion channel carried out offline from the existing river, so that excavation works can be carried out in a dry environment. A plug will be left in place at each end of the diversion channel to ensure that the existing river cannot breach and flow through the new channel prior to it being confirmed as stabilised.

The dimensions and design of the diversion will be confirmed within a SESCP however will likely be based on a low flow capacity only due to the large volume and flow conditions in the Ohau River. This results in a diversion that will have capacity for low flow only and any flows greater than this in a rain event will bypass the diversion and potentially through the works area. This is assessed as the most practicable solution and will require the contractor to ensure that the site of works always remains clean of contamination and has procedures in place when river flows are expected to exceed the diversion capacity. To assist with this the contractor will utilise Council river gauging data and flood warning systems.

The following will apply:

- Stabilisation of the newly constructed diversion channel will be carried out to ensure it does not become a source of sediment. This will be achieved using natural rock found in this location;
- Stockpiled material from the diversion will be placed on the northern side of the diversion channel; and will also be stabilised with either rock material or will be vegetated to ensure erosion is minimised;
- Once the diversion channel is confirmed as stabilised, the downstream plug will be removed to allow stream flows to enter the diversion channel. The upstream plug can then also be removed allowing stream flows through the diversion channel;
- Removing the downstream plug first helps to reduce scour in the diversion channel by keeping some water within it when the upstream plug is removed;
- A non-erodible (natural rock and potentially sandbag reinforcement) dam will then be placed within the original channel immediately downstream of the inlet to the diversion channel in order to divert flows into it. A non-erodible dam will also be immediately placed at the downstream end of the original channel, upstream of the diversion channel outlet to prevent

backflow into the construction area (if required) and to capture the work area within the dam features. Once the flows have been diverted and the dams placed, fish removal from the original channel can be completed in accordance with the Fish Management Plan. Construction activity can then take place within the original channel as required;

- Any water remaining within the original stream channel and works area will be pumped to the SRP that was previously established and located on the higher terrace. Pumped volumes will be monitored as per the permit to pump process to ensure that effective treatment occurs as necessary. It is likely that due to the nature of the substrate to be worked in this location that pumped water will be relatively clean and free of sediments;

- Although the works will only commence in a fine summer period, geotextile material will be available onsite to cover any exposed areas and stockpiles as required;

- The works will be staged as best practicable such that if flood conditions result the area can be fully stabilised in a few hours. Any sediment deposited within the newly formed channel will then be pumped to a SRP;

- As an alternative to the SRP a lamella plant could be operated if required as per Section 5.3.2 above; and

- Once the new intake structure has been constructed and the surrounding area stabilised then flows from the diversion can be transferred back into the original channel including any required fish relocation as per the Fish Management Plan.

If rainfall or high river levels occur during the course of construction this will be managed as below. In the event of forecast rainfall, or before leaving the work area for more than 24 hours the following will occur:

- Any loose material that could enter the river is to be removed from the work area and stabilised or placed outside the flood plain location;

- Where possible, all exposed soil areas will be covered with geotextile to ensure minimal scour issues. It is expected that this will be achieved through geotextile with the geotextile appropriately trenched in at the head and toe of the area;

- All existing and additional erosion and sediment control measures will be inspected, secured and maintained where required;

- Additional mulch and geotextile / polythene will be kept onsite at all times to cover exposed areas and stockpiled material; and

- Extended working hours will be considered if it is of significant benefit to complete works and overall duration with regard to programme and environmental impact.

Figure Eight below illustrates the Ohau River at the location of the proposed intake structure and Appendix C contains the details within an ESC Plan.



Figure Eight: Ohau River intake location

It is assessed that the above process, methodology and controls can be effectively implemented on site during Project construction.

6.1.4 Stockpile establishment and management

A stockpile is defined in the context of this ESCP as a temporary store of material that is placed and stored prior to re-use or disposal. The majority of materials to be stockpiled on the Project will be topsoil, unsuitable material -gained from the bulk earthworks operations - and aggregate material. It is anticipated that some imported hardfill will also be stockpiled.

Stockpiles can become a source of sediment and dust and will need to be carefully managed to ensure there are no environmental effects resulting from these areas.

As with all other earthworks the establishment of stockpiles will be subject to the development of a SESCP. From an ESC perspective, the establishment of material stockpiles will have regard to the following:

- Stockpiles should not be established within the flood extent of the Ohau River unless no alternatives are available, and they are addressed within the SESCP;
- ESC measures will be implemented and maintained to minimise sediment from leaving the stockpiles. SSFs will be provided on the 'low' side of the stockpile to ensure any sediment-laden runoff from the surface of the stockpile is treated prior to discharge;
- In some circumstances grass buffer zones will exist below stockpiles. If this grass buffer zone contains no concentrated flow paths and is a minimum of 100m in length and the associated stockpile has a maximum period of 14 days prior to stabilisation then such a grass buffer zone may provide a better environmental outcome rather than concentrating flows to a formal device. This will be detailed within the associated SESCP;
- Material stockpiled for longer than one month will be stabilised using vegetation, mulch, geotextile or an approved alternative detailed within the SESCP;
- Any vehicle transporting materials to be stockpiled, that may produce dust, will be managed to minimise dust during transportation; and
- Water will be sprayed on stockpiles from water carts to suppress dust during the construction period as necessary.

The specific location of temporary stockpiles has not been determined on the Project and will be confirmed and outlined within the SESCP. As part of the site visit undertaken and the assessment process, we have determined that there is adequate room available for stockpiles, particularly in the northwestern extent of the Project, and that the above measures will be adequate to ensure effects of runoff from these features are minor.

6.1.5 Construction yards

No formal construction yards are identified on the Project area and the successful contractor will determine the preferred location prior to works commencing.

Where established within the Project the ESC devices to be used for the establishment and operation of construction yards will be as follows:

- Stabilised Construction Entrances will be established as the entry point to the proposed construction yard to reduce transfer of sediment onto the external road network;

- If necessary CWDs will be established at the perimeter of the site to intercept and divert offsite water and overland flow from the catchment uphill of the construction yard from entering the areas;
- Super Silt fencing – these will be placed during the yard establishment phase of works if necessary;
- The construction yard establishment is recognised as a quick process whereby earthworks activity to establish the platform is completed as a single operation. The topsoil stripping and any subsoil stockpiles will be stabilised (likely with a mulch cover) immediately on establishment; and
- Immediately on reaching grade the yard area will be stabilised with a 50 to 100mm thick layer of clean hard fill material. This has the purpose of achieving immediate stabilisation but also ensuring traffic movement to and from the site will not be a generator of any further sediment yields.

7. Risk Assessment

The Project will be subject to ongoing stabilisation as works progress to minimise the open areas of earthworks and the potential for sediment generation (erosion) and subsequent sediment yield from the Project.

The key risk location for this Project is assessed as works within and adjacent to the Ohau River, primarily for the intake structure works.

To assist with an understanding of the nature and magnitude of this risk we have evaluated the area through site visits and plan assessments. In addition, through the development of SESCPs we will confirm and identify the risk and ensure this is documented including risk management options.

Monitoring and maintenance procedures will be defined further and confirmed through the SESCPs and will focus on pre-forecast rainfall monitoring and post rainfall monitoring to ensure all erosion and sediment controls are in place, are working as intended and are achieving the required outcomes and will also include a water quality monitoring programme of the receiving environment. The integrity of the diversion channel will be monitored and rectified as required.

A key risk management tool for the intake structure is minimisation of works duration. This will include ensuring that the contractor has all the necessary resources, skilled staff and equipment, in place and available on site to ensure that works can commence quickly without delay. In addition, working within a fine period only will form a key risk management provision.

For the overall Project, the erosion control practice of cut and cover methodologies will have a significant impact on reducing overall sediment generation and yield. To assist in this process, it is recommended that a 14-day maximum period of leaving exposed areas with no works occurring is assessed as a critical risk reduction element, and will in itself, encourage progressive stabilisation.

Within all earthworks, including the higher risk locations, both erosion and sediment controls will be installed to minimise, capture and treat sediment laden runoff that may enter the receiving environments. Additionally, as detailed above, for the higher risk locations the duration and timing of works will be minimised as far as practical to minimise disturbed soils exposed to heavy rainfall. It is recommended that as part of the SESCP process, this risk be specifically identified, the nature of the risk understood, the exposure of works to heavy rainfall are assessed and specific actions to manage this risk are identified and implemented.

7.1 Winter works

It also recognised that wetter periods of the year (e.g. May to September), which also corresponds to colder air and soil temperatures, may pose a higher risk for sediment discharges. This is due to increased rainfall, higher river flows, saturated soil profiles and also cooler temperatures reducing the ability for revegetation to occur. Earthworks within this period will need to reflect this higher risk which will be achieved through the SESCP process, whereby works during wetter periods will

require additional management procedures. This is supported by winter works "restrictions" where works over that period will be aligned with the climatic conditions and also the SESCP process which includes the identification of risk and risk management.

It is assessed that the intake structure construction only occurs in the summer period.

In some areas earthworks activities will likely to be required during the winter months and in accordance with the Horizons winter works standard procedures, should winter works be required in any given year a winter works application will be prepared and submitted to Horizons in writing by 1 April. This application will include:

- The nature of the proposed winter works, including the proposed locations;
- Identification of higher risk activities and locations;
- The proposed erosion and sediment control methodologies and any additional erosion and sediment controls required to manage the higher risk associated with working during the wetter winter period (e.g. chemical treatment of SRPs); and
- The proposed monitoring and maintenance schedule of the proposed erosion and sediment control methodologies.

For the winter period this risk assessment, which shall be undertaken within the SESCPs process, will specifically consider:

- The scope/nature of the proposed works;
- Structural controls proposed, or existing, that will be/are installed;
- Additional non-structural controls to be implemented (e.g. increased on site monitoring and staging); and
- Maintenance consideration of structural controls to ensure effective access can be achieved to undertake the maintenance and controls continue to work efficiently.

8. Monitoring

It is recommended that an adaptive monitoring programme be developed for the Project. This monitoring programme will involve ongoing site monitoring to check that the proposed water management measures have been installed correctly and that methodologies are being followed and are functioning effectively throughout the duration of the works.

Monitoring results that eventuate, as defined below, will also be used to identify future risks to the environment and will identify continuous improvement opportunities that should be considered by the construction team.

Water management measures and methodologies may be identified as requiring modification or improvement, including those causing raised levels of sedimentation.

The monitoring programme will include risk assessment to determine what further measures are required to reduce construction discharges. The adaptive monitoring will include a continual feedback loop until it has been verified that the implemented responses have been successful in minimising discharges from the Project construction.

8.1 Qualitative monitoring

8.1.1 Receiving environment - On-site visual assessments

The contractor will have an important role, to ensure that visual assessments of the receiving environment are maintained regularly throughout the works period with particular attention paid before, during and after periods of rainfall.

In the context of visual assessment, the receiving environment is defined as the immediate receiving environment adjacent to the area of works however, the wider freshwater environment of the Ohau River will also be subject to visual inspections.

Any noticeable change in water clarity from the water clarity prior to the rainfall event, or the water clarity upstream of the site of works, as a result of the earthworks activity will result in a review of the measures and practices and additional measures will be implemented and changes made as necessary under the adaptive management procedures.

8.1.2 Weather forecasting during Project implementation

Weather forecast monitoring will form an important part of the Project implementation to ensure that higher risk activities as defined in Section 7 of this ESCP will only occur during a suitable fine weather window.

We note the extensive use of weather forecasting that now occurs with most land-disturbing activities and the value that it provides in informing projects of upcoming weather systems.

8.1.3 On-site monitoring of water management devices

Monitoring of onsite devices is based upon the appropriate installation, location, maintenance, and monitoring of ESC devices. It is important that within the context of monitoring, the ESC devices are not restricted to physical structures and will also include work practices and methodologies.

This monitoring is aimed at the early detection of activities or problems that have the potential to result in an adverse environmental effect. The frequency of the monitoring will vary throughout the year and will reflect areas of changing activity and risk along the Project. During the construction period the monitoring will be undertaken daily and more frequently during heavy rainfall as defined by 25mm in 24 hrs and 15mm in a 1-hour period.

The inspections will include qualitative monitoring of the following:

- The integrity and effectiveness of all construction related water management devices;
- Construction activities onsite upstream of the water management device;
- General site conditions and other land disturbing activities occurring within the catchment; and
- General status of the immediate receiving environment.

The monitoring data will help to determine whether any further action is necessary. Where issues with the integrity and/or effectiveness of the devices and/or methodologies are observed these shall be rectified immediately.

8.1.4 Flocculation monitoring

A core part of flocculation management is monitoring in order to check that the systems are all working as anticipated and to provide information to facilitate management of the flocculation systems.

It is recommended that monitoring should be undertaken based upon checking the treated SRP discharge and receiving environment pH levels at weekly intervals and during rain events as defined in Section 8.1.3 above.

8.2 Quantitative monitoring

In addition to the qualitative monitoring as detailed above, quantitative monitoring will be undertaken on the Project with a focus on the intake structure works. The objective of this monitoring programme is to provide data for an array of rainstorms of different magnitudes and intensities to support the ESC effectiveness and identify areas of improvement.

This rainfall monitoring will be based on manual water quality monitoring of all SRP discharges and the Ohau River (upstream and downstream) during a rainfall event as defined above, unless the health and safety of the sampling personnel may be compromised. This monitoring will include the collection of a physical sample for total suspended solid concentration analysis or determination of turbidity using a field turbidity meter.

In addition, during the intake structure construction the same manual monitoring programme will occur however will be undertaken weekly within the Ohau River in addition to the rain event trigger.

Appendix C confirms a further monitoring point downstream from the reservoir works location and will also be subject to sampling on a weekly and rain trigger basis. This is located on the lower terrace and will provide an indication of groundwater quality leaving the area of activity.

This manual monitoring will allow for ongoing comparative analysis over time and will provide for continuous improvement and adaptive management of the ESC measures and methodologies adopted on the site.

9. Recommendations and conclusions

From an overall Project perspective, we assess that the effects of the construction aspects of the Project, in particular the discharge of sediment, are minor.

The following key points are noted for the Project.

- It is clear that those works associated with the intake structure and Ohau River are of a high risk and need careful and pro-active management and monitoring to ensure that the construction effects are minor.
- A range of ESC measures are proposed on the Project. ESCs will be based on both structural and non-structural measures with an emphasis placed on the non-structural management techniques.
- The Project's will rely on SESCPs to be submitted to Horizons at a later date, before any construction activity takes place, to allow for contractor input.
- An adaptive monitoring programme will be implemented which will allow for ongoing continuous improvement of the construction water methodologies.

10. References

Auckland Regional Council (1994). Storm Sediment Yields from Basins with Various Land-uses in Auckland Area.

Dam Watch Engineering Limited. Poads Road Water Storage Reservoir prepared for Horowhenua District Council. Issue 1 dated 17th March 2023.

Goldman, Steven J, Jackson, Katharine, Bursztynsky, Taras A. Erosion and Sediment Control Handbook. (1986)

Greater Wellington Regional Council (2021). Erosion and Sediment Control Guide for Land Disturbing Activities in the Wellington Region (February 2021).

NZ Transport Agency. Erosion and Sediment Control Guidelines for State Highway Infrastructure Construction Stormwater Management (September 2014).

Appendix A. General Layout Plans

Notes Keys and References

Standpipe Piezometer Coordinates

Point #	Northing	Easting	Elevation (mRL)	ID
1	5496314.83	1799307.28	131.88	SP-1
2	5496439.90	1799145.00	131.88	SP-2
3	5496531.30	1799149.89	131.88	SP-3
4	5496587.65	1799259.67	131.88	SP-4
5	5496599.81	1799330.73	131.88	SP-5
6	5496580.85	1799470.02	132.00	SP-6
7	5496505.44	1799520.42	131.88	SP-7
8	5496445.95	1799482.84	131.88	SP-8

Proposed access road refer dwg PDR2142-30-102

Open channel

Proposed monitoring weir location (refer dwg PDR2142-30-180)

Pumping Station, Diesel Generator, Bubbler facility, Transformer Stores, EVA turning circle

EVA turning circle (indicative)

Ohau River

West Toe drain

Ground Water Toe drain

East Toe drain

Pavement

Carpark

Pumping Station

Diesel Gen

Bubbler Facility

Spillway

Vehicle access (indicative)

Infiltration Gallery Intake

Sedimentation Pump Sump

Pump Sump Intake

Thrust block For detail, refer dwg PDR2142-30-144

Draw Down Vertical Stilling Well refer dwg PDR2141-30-171

Refer dwg PDR2141-30-124

Twin Rising Main to WTP refer dwg PDR-30-190

Proposed Boat Ramp Refer dwg PDR2142-30-220

SP- 1

SP- 2

SP- 3

SP- 4

SP- 5

SP- 6

SP- 7

SP- 8

1:3

1:2.5

1:2

1:300

2 x Upper, 2 x Lower, Draw-Off For general arrangement/detail, refer dwgs PDR2142-30-143,144.

Lateral Pipes (10 nos.) with 40m spacing

Spine Pipe Arrangement refer dwg PDR2142/30/182

Infiltration gallery detail layout refer dwg PDR2142-30-121

5.0m corridor for maintenance access and site fencing.

Refer dwg PDR2141-30-181

3.0m corridor for maintenance, site fencing and planting (if required).

Embankment crest

Existing access to farmhouses

Poads Road parcel boundary

Concrete beam near upstream end of spillway (refer dwg PDR2142-30-164)

Poads Road boundary parcel approximately 15.0m wide

3.0m corridor for maintenance, site fencing and planting (if required).

Embankment crest. Access to spillway.

13.0 m corridor for bypass access

Existing Parcel Boundary

Farmhouses

N

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R3	Reservoir shifted, setbacks noted, coords updated	R.L.	J.E.		
R2	Reservoir shifted	R.L.	J.E.		
R1	Issue for Comments	FS	JE		

Graphic Scales 1:2500 0 20 40 60 80 100 120 m

Notes:

1. All co-ordinates are to NZTM and levels are to NZVD2016 mean sea level.
2. Site boundaries sourced from LINZ database.
3. Embankment set-back 6 metres minimum from site boundaries.
4. Contours from LINZ LiDAR survey 2016.

Existing Parcel Boundary

8 No. Survey mark central on embankment crest. Refer BCI1613/30/52 for detail.

SP- x 8 No. Standpipe piezometers on embankment crest.

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

GENERAL LAYOUT PLAN

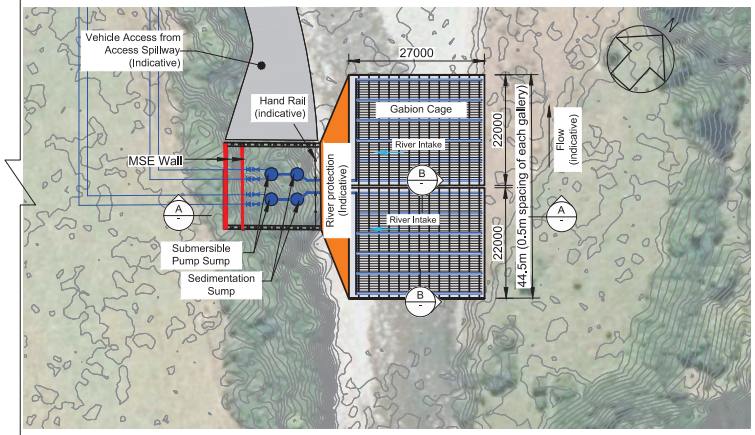
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Original Sheet Size A3 (420x297)

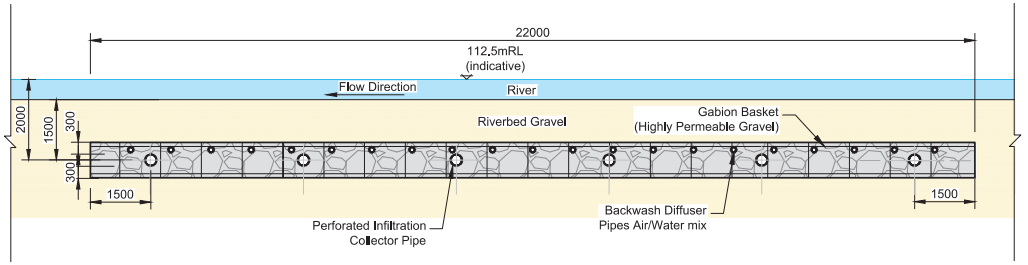
Damwatch Engineering, Wellington Club Building Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
info@damwatch.co.nz
+64 4 381 1300

12 July 2023 2:20pm
C:\12d5\data\dmw-wlg-vms-003\E2142A Poads Road - Feasibility Design_280\6. CAD\DWG\PDR2142-30-104_180_181_182-Dam Safety Monitoring_23022023.dwg (104-Gen Layout Plan)

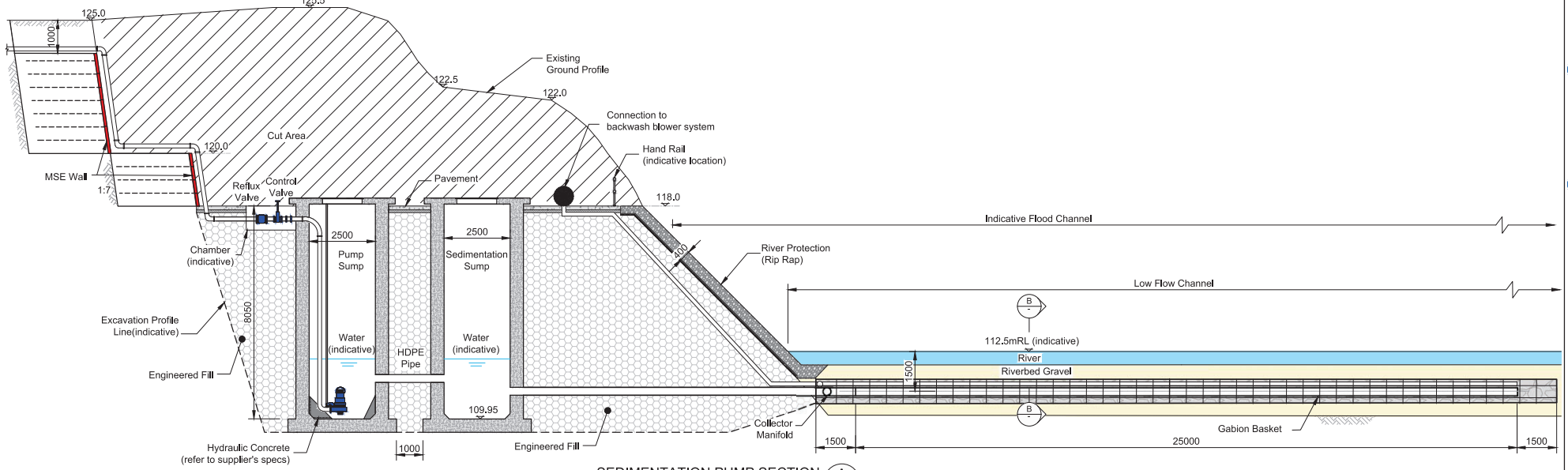
Notes Keys and References



INFILTRATION SUMP LAYOUT PLAN - 1:500



TYPICAL PEFORATED INFILTRATION SECTION B - 1:125



SEDIMENTATION PUMP SECTION A - 1:150

Rev	Comments	Drawn	Chk'd	Appr'd	Date
R1	Issue for Comment	FS	FZ	S.M.	16/03/23

Notes:

1. All co-ordinates are to NZTM and levels are to NZVD2016 mean sea level.
2. Site boundaries sourced from LINZ database.
3. Embankment set-back 6 metres minimum from site boundaries.
4. Contours from LINZ LiDAR survey 2016.

Horowhenua DISTRICT COUNCIL

DAMWATCH ENGINEERING BEYOND THE SURFACE

Title
HOROWHENUA DISTRICT COUNCIL
POADS ROAD
WATER SUPPLY RESERVOIR

RIVER INTAKE
PLAN, SECTION OF PUMP
AND SEDIMENTATION SUMP

Scale	Project	Drawing Number	Revision
AS SHOWN	E2142A	PDR2142/30/121	R1

Graphic Scales

Original Sheet Size A3 (420x297)

Damwatch Engineering, Wellington Club Building, Level 3, 88 The Terrace, PO Box 1549, Wellington 6140, New Zealand
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C:\E2142\data\dmw-wlg-vms-fs04\E2142A Poads Road - Feasibility Design_2806\6. CAD\DWG\PDR2142-30_022023.dwg (121-Pump Sed Sump Plan_Section)
23 February 2023 12:17pm

Appendix B. ESC Principles

A2.0 Fundamental principles of erosion and sediment control

An awareness of where water goes and the sensitivity of the receiving environments are fundamental to determining requirements for erosion and sediment control for land disturbing activities. The following ten fundamental principles of ESC provide best-practice guidance for minimising the adverse effects of erosion and sedimentation through the planning, construction and maintenance phases of a project. These should be followed when preparing and implementing an ESC plan.

1. Minimise disturbance

Consistent with the concepts of water sensitive design, the identification and retention of existing site attributes should be incorporated into project designs, and earthworks should be minimised to the greatest practicable extent.

Land development should be fitted to land sensitivity and where possible, disturbance should avoid steeper slopes and other features such as streams and wetlands.

For any development, the total area of earthworks should be the minimum necessary to achieve the design outcome (including temporary works). The area of earthworks exposed to erosion at any given time should also be minimised through staging and progressive stabilisation.

2. Stage construction

Carrying out bulk earthworks over the whole site maximises the time and area that soil is exposed and prone to erosion. By only exposing those areas that are required for active earthworking at any one time, the duration of exposure and risk of erosion/sediment discharge can be minimised. 'Earthworks staging', where the site has earthworks undertaken in smaller units over time with progressive revegetation, limits erosion.

Careful planning is needed. Temporary stockpiles, access and utility service installation all need to be planned. Earthworks staging needs to be planned in conjunction with the overall construction sequencing to ensure that it accommodates the contractor's requirements.

3. Protect slopes

If slopes are worked and require stabilisation, simple vegetative covers such as topsoiling and seeding may not be immediately effective and additional measures may be required. These are described in Section E3.0 of Part 2 - Practices. Disturbance of existing slopes should be avoided wherever possible, particularly steep slopes which have a higher risk of erosion. To minimise erosion, clean water runoff from above the site must be diverted away from the exposed slopes.

4. Protect receiving environments

Receiving environments including sensitive receiving environments, existing streams, watercourses and proposed drainage patterns need to be mapped. Earthworks and the removal of vegetation beside or within streams (including intermittent streams), wetlands and the coast, typically require consents from Greater Wellington Regional Council. GWRC should be consulted on these matters prior to finalising project designs.

All receiving environments, limits of disturbance and protection measures should be mapped on the ESC Plan. In addition, all practices to be used to protect new drainage channels should be marked, as well as crossings, disturbances and associated construction methods.

5. Rapidly stabilise exposed areas

Disturbed soils should be progressively stabilised with vegetation, mulch, grassing or other stabilising methods after each earthworks stage and at specific milestones within stages. Available stabilisation methods are site-specific and are described in Section E3.0 of Part 2 - Practices.

6. Install perimeter controls and diversions

Perimeter controls and diversion measures help separate 'clean water' from outside the area of disturbance from 'dirty water' that has flowed through the disturbed area. Minimising the earthworks catchment by diverting clean runoff away from the works area is a critical erosion control measure. It also reduces the size of sediment control devices required for any given works area. Perimeter and diversion controls can also retain or direct sediment-laden runoff within the site. Common controls are diversion drains and earth bunds. These are detailed in Section E2.0 of Part 2 – Practices.

7. Employ sediment retention devices

Even with the best ESC practices, earthworks will discharge sediment-laden runoff during and immediately following storms. Along with erosion control measures, sediment retention devices are needed to capture runoff so generated sediment can settle out and be retained on site. These are detailed in Section F1.0 of Part 2 – Practices.

The fine-grained nature of Wellington soils means sediment retention ponds will usually require flocculant treatment (flocculation) to maximise their efficiency. All sediment retention devices must be sized and maintained in accordance with this guideline, and must be appropriate for any given location within a site.

8. Get trained and develop experience

As contractors are generally responsible for installing and maintaining ESC practices, a trained and experienced contractor is an important element of an ESC Plan. Trained and experienced staff can save projects time and money through proactive construction and maintenance of ESCs. Staff should be encouraged to become experienced in ESC. Key staff should also be assigned to provide that role, so that the appropriate level of experience and supervision is available for each new project.

9. Adjust the ESC Plan as needed

An effective ESC Plan is modified as a project progresses from bulk earthworks to a fully developed site. Factors such as weather, changes to grade, altered design including drainage and formation of roads can require changes to initial ESC design.

The ESC Plan should be updated to suit site adjustments in time for the pre-construction meeting and initial inspection of installed ESCs. The Plan must also be regularly referred to and available on site. Prior to works commencement, consideration should be given as to how the site will change throughout the project, and how the ESC Plan will need to evolve to reflect this.

Note: For consented sites, adjustments to the ESC Plan may require sign-off from Greater Wellington Regional Council.

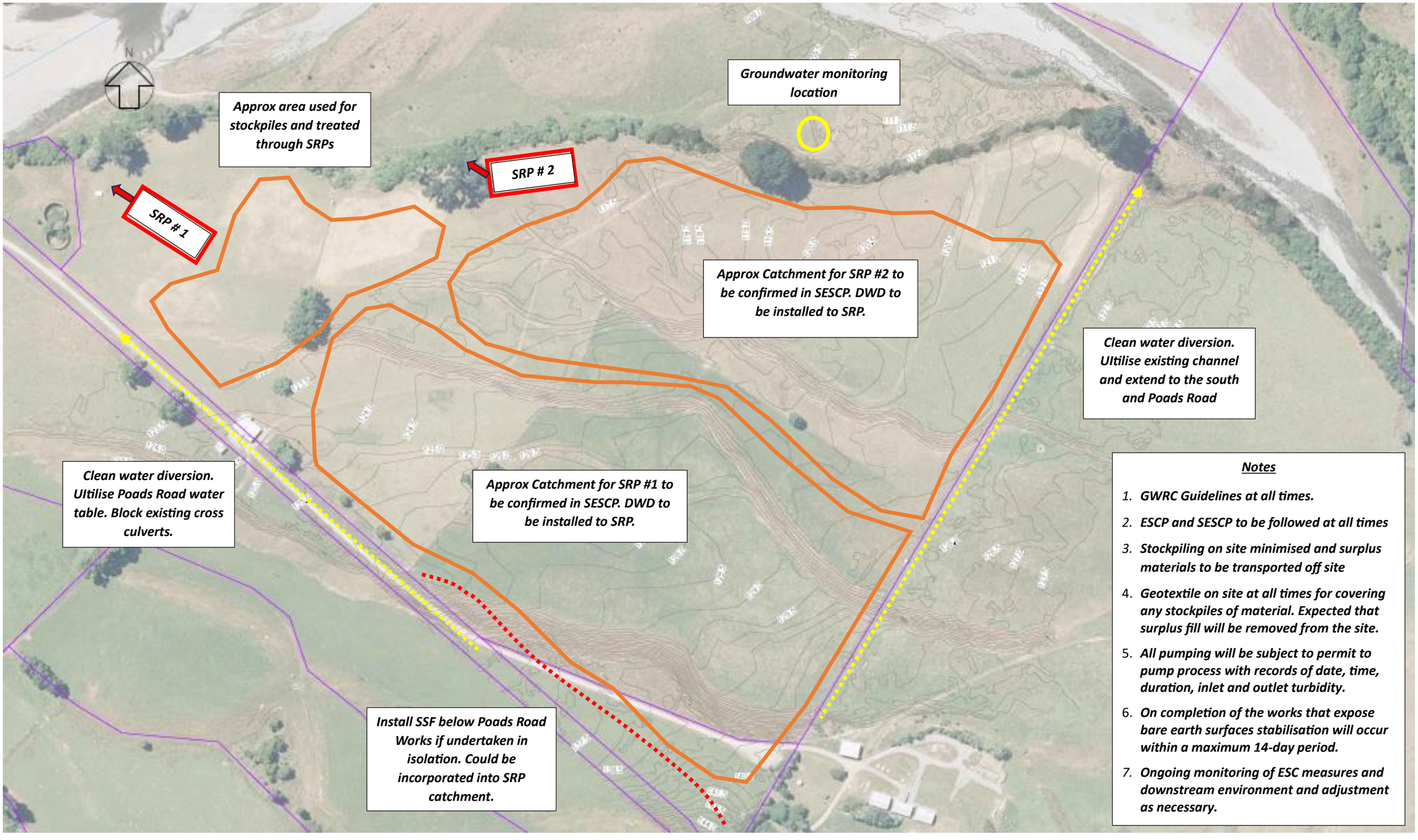
10. Assess and adjust your ESC measures

ESC measures need to be inspected, monitored and maintained.

Inspection and maintenance of controls is especially important prior to and following a storm event. A large or intense storm can leave ESC measures in need of repair, replacement, reinforcement or cleaning out. Maintaining and repairing measures as soon as possible after a storm event will maximise the ongoing efficiency of the measures and minimise adverse environmental effects.

Appendix C. ESCP Drawings

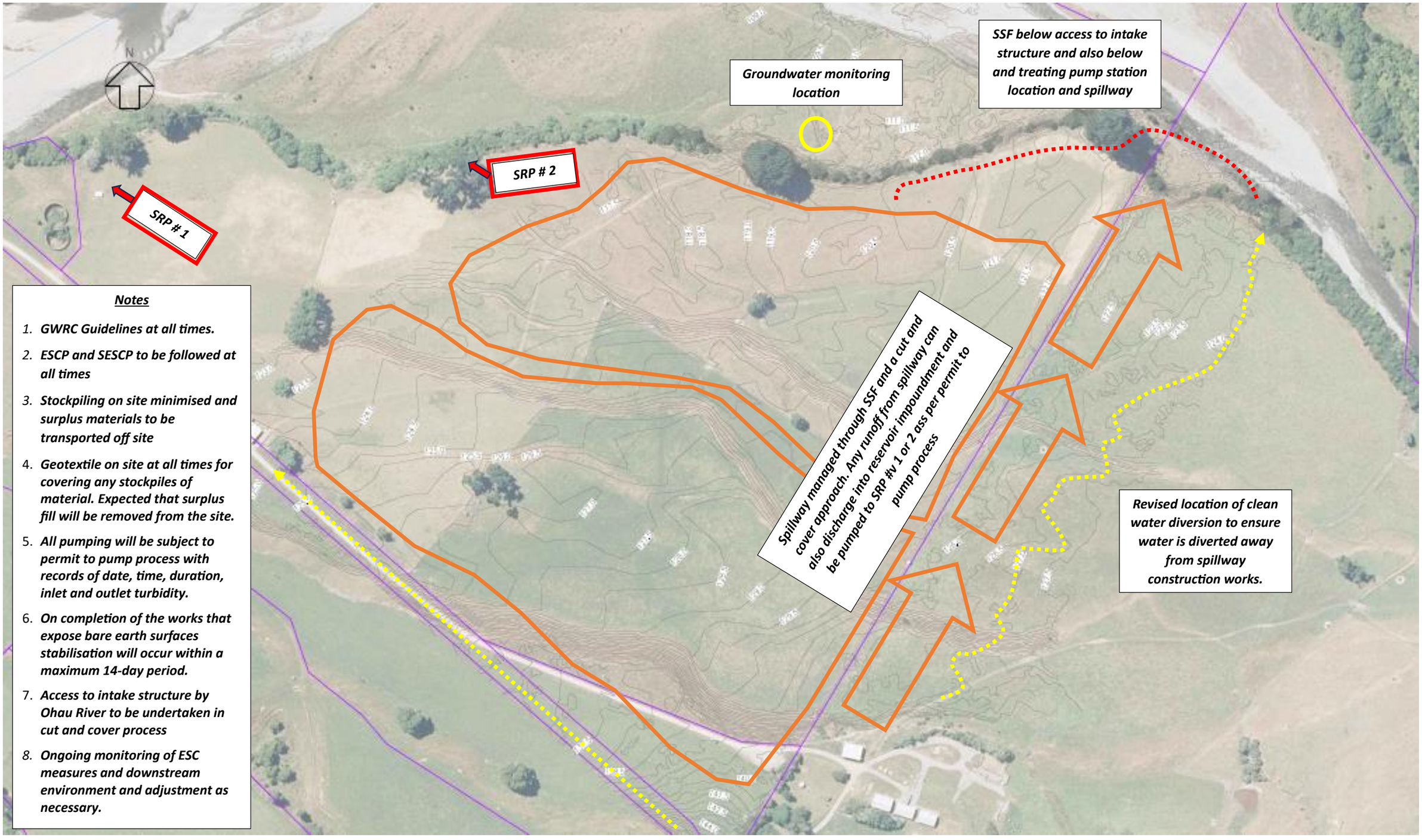
Poads Road Water Reservoir – Conceptual Erosion and Sediment Control Plan ESCP 001 – Revision # 1 July 2024



Notes

1. ***GWRC Guidelines at all times.***
2. ***ESCP and SESCP to be followed at all times***
3. ***Stockpiling on site minimised and surplus materials to be transported off site***
4. ***Geotextile on site at all times for covering any stockpiles of material. Expected that surplus fill will be removed from the site.***
5. ***All pumping will be subject to permit to pump process with records of date, time, duration, inlet and outlet turbidity.***
6. ***On completion of the works that expose bare earth surfaces stabilisation will occur within a maximum 14-day period.***
7. ***Ongoing monitoring of ESC measures and downstream environment and adjustment as necessary.***

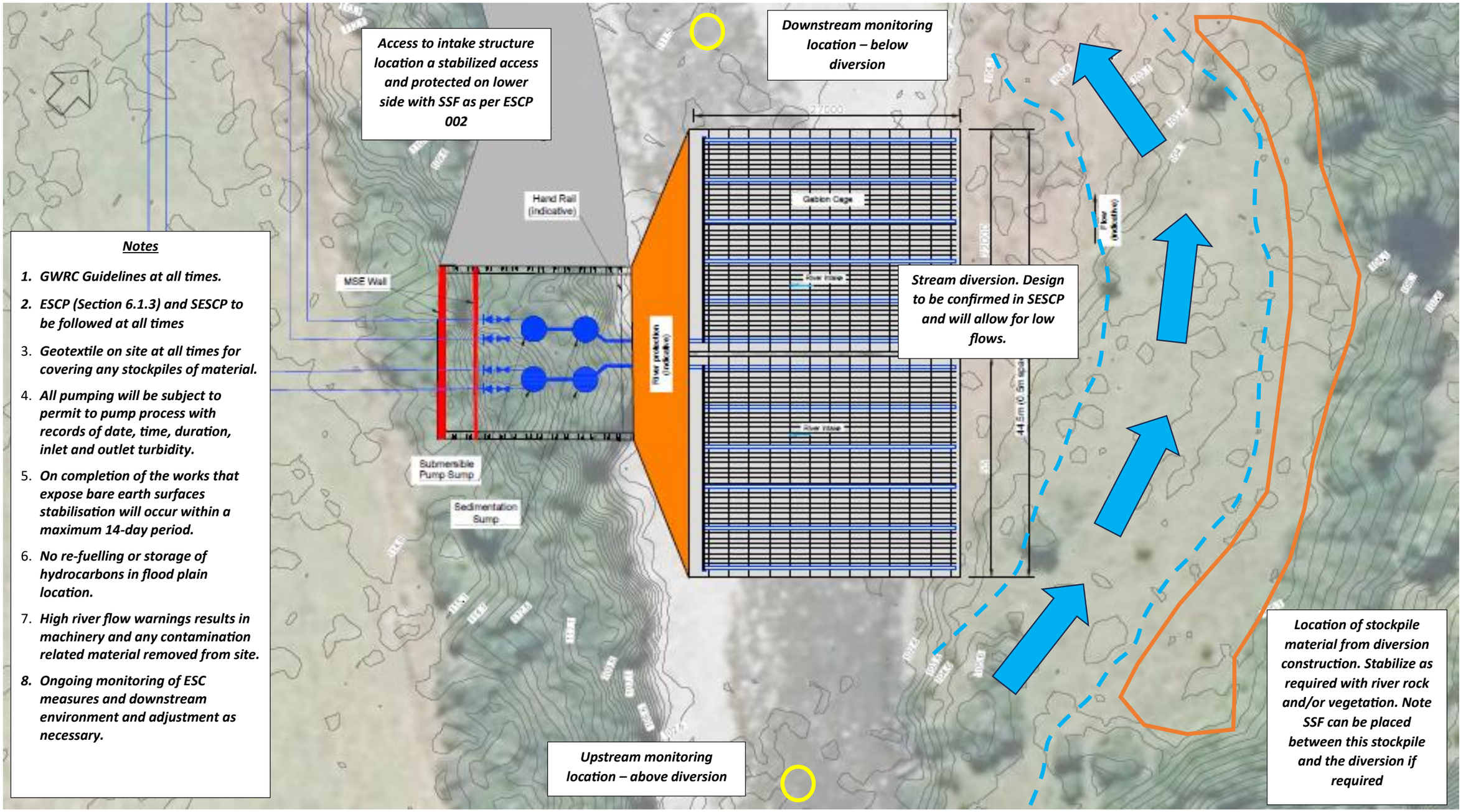
Poads Road Water Reservoir Spillway – Conceptual Erosion and Sediment Control Plan ESCP 002 – Revision # 1 July 2024



Notes

1. ***GWRC Guidelines at all times.***
2. ***ESCP and SESCP to be followed at all times***
3. ***Stockpiling on site minimised and surplus materials to be transported off site***
4. ***Geotextile on site at all times for covering any stockpiles of material. Expected that surplus fill will be removed from the site.***
5. ***All pumping will be subject to permit to pump process with records of date, time, duration, inlet and outlet turbidity.***
6. ***On completion of the works that expose bare earth surfaces stabilisation will occur within a maximum 14-day period.***
7. ***Access to intake structure by Ohau River to be undertaken in cut and cover process***
8. ***Ongoing monitoring of ESC measures and downstream environment and adjustment as necessary.***

Poads Road Intake Structure – Conceptual Erosion and Sediment Control Plan ESCP 003 – Revision # 1 July 2024



Notes

1. ***GWRC Guidelines at all times.***
2. ***ESCP (Section 6.1.3) and SESCP to be followed at all times***
3. ***Geotextile on site at all times for covering any stockpiles of material.***
4. ***All pumping will be subject to permit to pump process with records of date, time, duration, inlet and outlet turbidity.***
5. ***On completion of the works that expose bare earth surfaces stabilisation will occur within a maximum 14-day period.***
6. ***No re-fuelling or storage of hydrocarbons in flood plain location.***
7. ***High river flow warnings results in machinery and any contamination related material removed from site.***
8. ***Ongoing monitoring of ESC measures and downstream environment and adjustment as necessary.***

Appendix D. SRP Calculations

SEDIMENT RETENTION POND - DESIGN SHEET								1-Jul-24
Project:		**Levin Water Supply**						
Calculations By:		**Graeme Ridley**	**Date:**	**5/07/2024**				
Checked By:			**Date:**					
RDE		**Levin Poads Road SRP Design**						
SRP Reference		**SRP # 1 and 2 - Conceptual design to be confirmed prior to construction and subject to as builts**						
SRP DETAILS		**DESIGN SPECIFICATIONS**						
CONTRIBUTING CATCHMENT		Area (ha)	**5**	Volume Criteria	**3%**			
POND MAIN BODY DETAILS								
Required Total Volume: (Dead + Live Storage)		Required Total Volume (m^3)	**1500.00**	*3 % Volume (i.e 300 m3 / ha)*				
Required Live Storage Volume: (70% Total)		Required Live Storage Volume (m^3)	**1050.00**	**70%**	Pond Depth (Inv to Top of Primary Spillway)	**2.00**		
Required Dead Storage Volume: (30% of Total)		Required Dead Storage Volume (m^3)	**450.00**	**30%**	Live Storage Depth (m)	**1.25**		
Depth - Primary Spillway to Invert Level (m)			**2.00**		Dead Storage Depth (m)	**0.75**		
Freeboard: Primary to Emergency Spillway (m)			**0.30**					
Depth: Emergency Spillway to Invert Level (m)			**2.30**	**Refer to Figure 72 of GWRC 2021 Guidelines**				
Length:Width Ratio *(between 3:1 to 5:1)*			**3**					
Inlet Slopes (x:1)			**3**					
Side and Outlet Slopes (x:1)			**2**					
POND MAIN BODY (PHYSICAL DIMENSIONS)								
Pond Dimensions @ Midslope (1 m) above Invert		Length (m)	**48.00**	Width (m)	**16**	3		
Pond Dimensions @ Emergency Spillway Level (2.3 m) Above Invert Level		Length (m)	**54.50**	Width (m)	**21.2**			
Pond Dimensions @ Primary Spillway (2 m) Above Invert		Length (m)	**53.00**	Width (m)	**20**			
Pond Dimensions at Mid Point		Length (m)	**49.25**	Width (m)	**17**			
Pond Dimensions @ Dead Storage Level (0.75 m) Above invert		Length (m)	**46.75**	Width (m)	**15**			
Pond Dimensions @ Invert Level		Length (m)	**43.00**	Width (m)	**12**			
POND MAIN BODY (VOLUME CHECK - BASED on PHYSICAL DIMENSIONS)								
Check - Total Main Body Volume - Primary Spillway to Invert		Volume (m^3)	**1549.33**	**OK: Design Volume > Required Volume**		**103%**	**Of Required Volume**	
Check - Live Storage Volume (Dead Storage Level to Primary Spillway)		Volume (m^3)	**1094.27**	**OK: Design Volume > Required Volume**		**104%**	**Of Required Volume**	
Check - Dead Storage - (Invert to Dead Storage Level)		Volume (m^3)	**455.06**	**OK: Design Volume > Required Volume**		**101%**	**Of Required Volume**	
Baffle Type & Siting *(if required)*			**Not Required**					
FOREBAY DESIGN								
Minimum Volume (10% of Total)		Required Forebay Volume (m^3)	**150.00**	Side Slope (x:1)	**1.00**			
Forebay Depth		Forebay Depth (m)	**1.00**					
Forebay Dimensions at Level Spreader		Length @ Level Spreader (m)	**8.50**	Width (m) @ Primary Spillway level	**21.20**			
Forebay Dimensions at Base		Length @ Base (m)	**6.50**	Width @ Base (m)	**19.20**			
Forebay Volume		Design Vol(m^3)	**151.65**					
Forebay Volume Check		**OK: Design Volume > Required Volume**						
Level Spreader Width and Height		Level Spreader Width (m)	**20**	Level Spreader Height (mm)	**50**			
PRIMARY SPILLWAY DETAILS								
Manhole Riser Required			**Yes**					
Weighted Manhole Riser			**Y**					
Primary Spillway Diameter and Height above Invert		Diameter (mm)	**MH Riser**	Height above pond invert (m)	**2**			
Oulet Pipe Diameter & Grade		Diameter (mm)	**300**	Grade (%)	**1%**			
Type of Stabilisation at Outlet			**Rock Rip Rap**					
Number of Antiseep Collars Installed		Number	**1**					
Freeboard between Primary & Emergency Spillway		Height above Riser (mm)	**300**					
DECANT DETAILS								
Number of Floating Decants To Be Installed		Number	**3**					
Decant Discharge Rate (3 l/s/ha)		Rate (ls^{-1})	**15.00**	# Holes/decant	**222**			
1st Decant Setting *(height from invert)*		Bottom Wire Setting (m)	**0.75**	Top wire Setting (m)	**2.00**			
2nd Decant Setting *(height from invert)*		Bottom Wire Setting (m)	**1.17**	Top wire Setting (m)	**2.00**			
3rd Decant Setting *(height from invert)*		Bottom Wire Setting (m)	**1.58**	Top wire Setting (m)	**2.00**			

Appendix K

FUNCTIONAL NEED ASSESSMENT FOR RESERVOIR AS SPECIFIED INFRASTRUCTURE

POADS ROAD WATER SUPPLY RESERVOIR: FUNCTIONAL NEED ASSESSMENT FOR SPECIFIED INFRASTRUCTURE

By: Annette Sweeney, CPEng, Good Earth Matters

Date: 31 July 2024

1. INTRODUCTION

Horowhenua District Council (HDC) has identified the need to augment their current water supply and storage facilities to serve the township of Levin. The Levin water supply currently sources its drinking water direct from the Ohau River and is treated to the New Zealand Drinking Water Standards. While there is sufficient water to meet current needs, the community is experiencing significant growth which is expected to continue in the medium term.

A Water Supply Augmentation Operational Framework Report[1] (the WSAOF report) was prepared to assess water requirements to reduce the effects of the existing abstraction on the Ohau River, improve the resilience of the supply, and consider options for alternative water sources for meeting Levin's water supply needs for the 50-year planning time frame. It considered the various factors that will affect future demand for potable water including community growth, changing environmental and cultural expectations, climate change and new regulatory regimes.

The assessment concluded the preferred option for the Levin Water Supply is provision of a Bulk Off-River Raw (untreated) Water Storage Reservoir and additional water allocation provided via securing a resource consent for supplementary allocation to allow for water harvesting from the river. The WSAOF report identified, via a constraint mapping process, three possible sites for the reservoir, of which one is a property which HDC had acquired on a willing-seller, willing-buyer basis for this purpose. Damwatch Engineering was commissioned by HDC to develop the feasibility engineering design of a 740,000m^3 water storage reservoir at that property, being the HDC-owned property on Poads Road (Damwatch, March 2023[2]) to inform the Assessment of Environmental Effects that will be submitted alongside the resource consent application currently being prepared by Good Earth Matters on behalf of HDC.

2. BACKGROUND AND PURPOSE OF MEMO

At the time that the property was acquired, and during the period that the WSAOF and Feasibility Design was being developed, it was understood, based on initial advice from HDC's ecological advisors for this project (Wildland Consultants), that there were no natural inland wetlands on the proposed reservoir site. A further ecological assessment and wetland delineation was undertaken by Wildland Consultants and reported on in their draft report of November 2023 (subsequently finalised in July 2024)[3].

This assessment has identified a potential Natural Inland Wetland within the development footprint of the reservoir. Wildlands Consultants (2024) describes it as a:

> *… small open-water shallow depression covering an area of c. 400m^2 with a narrow fringe of wetland vegetation …*

---

1 *Horowhenua District Council (March 2023). Levin Water Supply - Water Supply Augmentation Operational Framework March 2023 - REV 3.*

2 *Damwatch Engineering (March 2023). Poads Road Water Storage Reservoir - Feasibility Design Report. Prepared for Horowhenua District Council. 201pp.*

3 *Wildland Consultants (2024). Wetland Delineation at Poads Road, Levin. Wildlands Consultants Contract Report No. 6201c-2. Prepared for Horowhenua District Council. 16pp.*

The wetland delineation methodology included the assessment of two representative 2 x 2 metre vegetation plots in the narrow strip of vegetation surrounding the small area of open water. It was found that one of these plots would qualify the site as being classified as a natural inland wetland while the other plot would not quality the site as a natural inland wetland. Wildland Consultants Ltd concluded that **"the site could be classified as a wetland but it is a very marginal classification".** The location of this wetland within the development footprint of the proposed reservoir is shown in Figure 1.

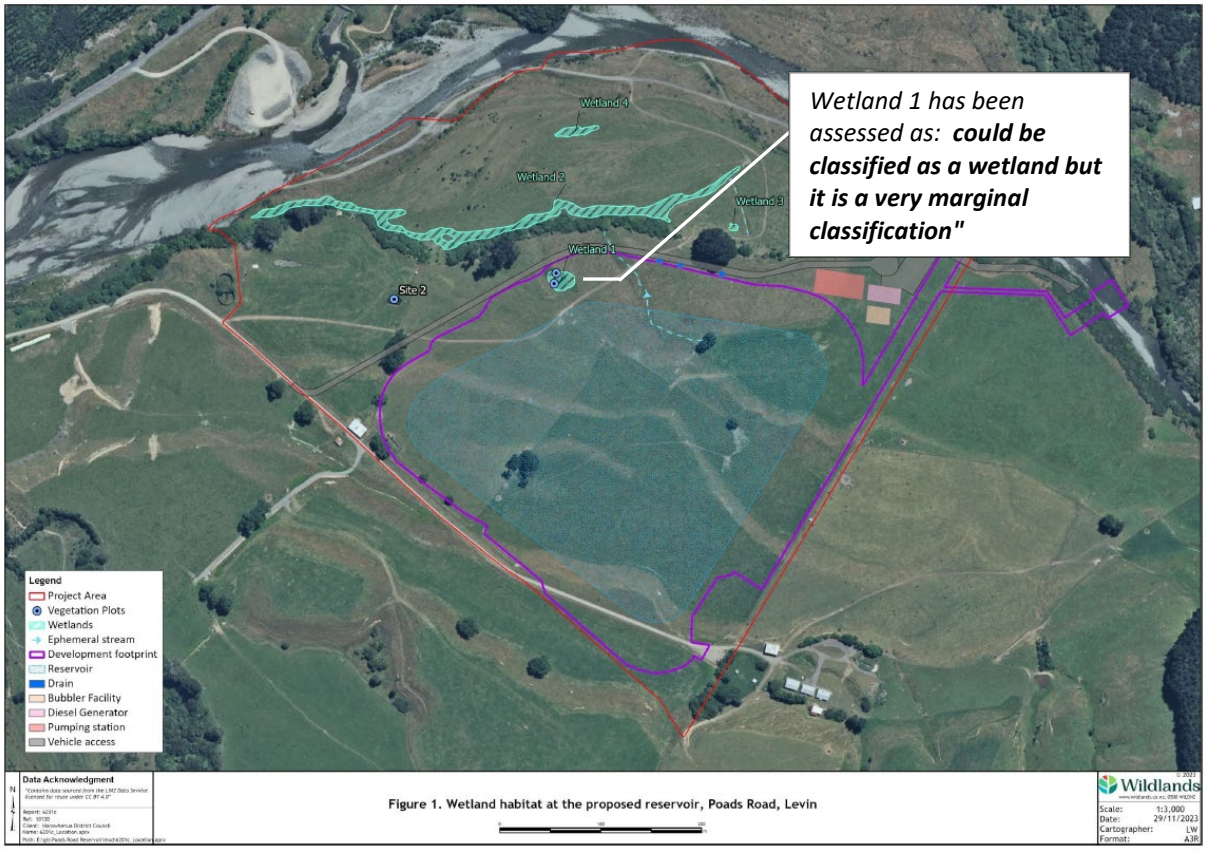


Figure 1: Wetland Habitat at Proposed Reservoir Site
Source: Wildland Consultants (2023), notated by Good Earth Matters

Regulation 45 of the Resource Management (National Environmental Standards for Freshwater) Regulations 2020 (NES-FW) states:

> *(2) Earthworks or land disturbance within, or within a 10 m setback from, a natural inland wetland is a discretionary activity if it is for the purpose of constructing specified infrastructure.*
>
> *(3) Earthworks or land disturbance outside a 10 m, but within a 100 m, setback from a natural inland wetland is a discretionary activity if it—*
>
> *(a) is for the purpose of constructing specified infrastructure; and*
>
> *(b) results, or is likely to result, in the complete or partial drainage of all or part of the natural inland wetland.*

Regulation 45 further states that:

> *(6) A resource consent for a discretionary activity under this regulation must not be granted unless the consent authority has first—*
>
> *(a) satisfied itself that the specified infrastructure will provide significant national or regional benefits; and*

(b) satisfied itself that there is a functional need for the specified infrastructure in that location; and

(c) applied the effects management hierarchy.

The resource consent application will provide a planning assessment with respect to the above matters. This memo has been prepared to inform that assessment by assessing the functional need for the specified infrastructure (i.e. the water supply reservoir).

3. DEMONSTRATION OF FUNCTIONAL NEED

Functional need is defined in clause 3.21 the National Policy Statement for Freshwater Management 2020 as "the need for a proposal or activity to traverse, locate or operate in a particular environment because the activity can only occur in that environment". Therefore, to assess the functional need for the reservoir as *specified infrastructure in that location* (at Poads Road), there are two aspects which must been considered:

- The location of the reservoir (i.e., does the reservoir need to be located on that site)
- The size (and footprint) of the reservoir (i.e., does the reservoir need to be of such a size that it affects the potential natural inland wetland).

The WSAOF report found that there were three possible sites where the reservoir could potentially be located. It did not undertake any assessment of those sites, given that the proposed site had already been acquired and, at the time, it was understood that there were no natural inland wetlands on the site. Given the recent assessment of a site that could be classified as natural inland wetland, the following further assessment of functional need relating to location and size of the reservoir has been undertaken.

3.1 Location of reservoir

The Options Assessment section of the WSAOF report details the constraints mapping approach taken to identifying the preferred site at Poads Road as proposed.

The factors assessed for selection of the preferred site are summarised below.

- A site upstream of the existing intake and Water Treatment Plant.
  - To ensure similar or better source water quality, in order to not introduce new source water risks and avoid/minimise requirement for additional treatment processes.
  - Efficient conveyance of stored water from the reservoir to the Water Treatment Plant.
- A property size greater than 40ha to accommodate a reservoir of sufficient size to meet the future demand.
- Avoidance of Outstanding Natural Features, Landscape Areas and Important Ridgelines as identified in the District Plan.
- Consideration of culturally significant areas in the vicinity.
- Avoidance of known fault lines.
- Reservoir to be sited outside of the active river corridor and flood plain.
- Avoidance of the National Grid Transmission Line corridor.

There were six properties identified that were not limited by the above constraints. Three on the northern side of the Ohau River were excluded further due to steep terrain, forestry cover and the presence of watercourses. Of the remaining three, the property at Poads Road (Lot 9 DP 555714) was purchased by HDC when available on a willing-seller, willing-buyer property basis. The WSAOF report further stated that "*since purchase, further assessment of this [Poads Road property] has confirmed that:*

- *The portion of the site for the reservoir is mostly exotic grassland and there are no natural wetland features or areas of rare, threatened or at-risk habitats* [Note that this is no longer understood to be the case as per the wetland assessment discussed above].
- *Geotechnical conditions are suitable for reservoir construction and on-site materials are suitable in sufficient quantities for construction of the reservoir embankments.*
- *The site is of sufficient size that a single reservoir of approximately 700,000 m^3 capacity can be constructed."*

The constraints mapping approach in the WSAOF therefore identified the preferred location of the proposed reservoir at Poads Road, Lot 9 DP 555714, being the HDC owned property.

Given that it is now understood that there is a potential natural inland wetland on the property, the other two sites identified in the constraints mapping of the WSAOF have been considered further as follows.

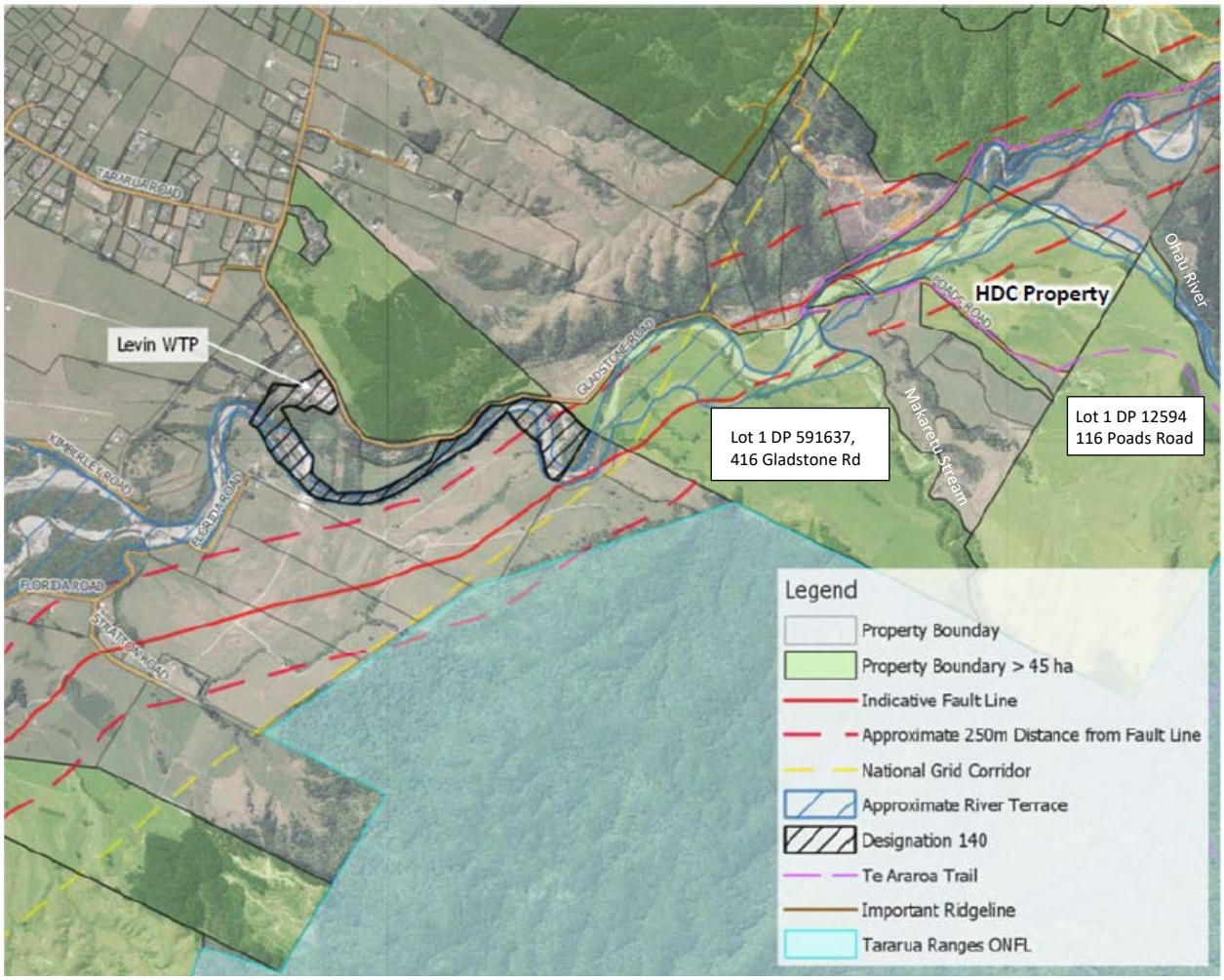


Figure 2: Properties Identified in Water Supply Augmentation Operational Framework (WSAOF) Report
Source: Figure of 4.4 of WSAOF

Lot 1 DP 12594, 116 Poads Road

This is a 112 ha property adjacent to the HDC property. The proposed intake to be constructed in the bed of the Ohau River to abstract water for the reservoir is located on this property, and HDC is currently negotiating an easement for this infrastructure.

Desktop mapping assessment of this property has identified that the majority of the site is rolling hill topography with numerous watercourses through these areas. While the overall property size is large, the area of land within the property that is relatively flat and adjacent to the river, such that it would be suitable for reservoir construction, is only approximately 8 ha. This would significantly reduce the size of any reservoir that would be able to be constructed on the property to that comparable with a reduced reservoir size assessed under section 3.2 below. A reservoir on this property would therefore not meet the water supply objectives and resilience standards sought by Council for the same reasons as detailed in section 3.2 below.

Further, this property does not include any floodplain / lower terrace area such as that on the HDC property that is to be used for Cultural Offsetting. Muaūpoko Tribal Authority's (MTA's) Cultural Impact Assessment for the proposed reservoir identified that:

> *"The proposed quantum of water taken from the Ohau Awa, especially at low flow will affect the mauri of the awa, other waterbodies and groundwater that are hydraulically connected to it. The impact on mauri will have adverse effects on Muaūpoko values which must be managed, positive actions must be undertaken to enhance the mauri of the Ohau Awa to offset for the effects the water take will have. The necessity of the project is recognised and Muaūpoko is supportive of a more resilient water supply for Taitoko and the surrounding communities."*

To address the effect of the Levin water supply abstraction on the mauri of the Ohau Awa and the identified adverse effects on Muaūpoko values, MTA recommended consent conditions requiring a Cultural Offsetting Management Plan (COMP) be developed and implemented. HDC has recognised and acknowledges the findings and recommendations of the CIA and has further engaged MTA to develop a draft COMP prior to this being imposed by way of consent conditions (i.e. they have implemented this recommendation early, ahead of any consent decision). The draft COMP assessed the length of the Ohau Awa from the proposed reservoir intake site to the existing Water Treatment Plant intake for potential offset mitigation sites and identified the lower floodplain area on the HDC owned property as the preferred offset site. It did not identify any potential cultural offset sites within Lot 1 DP 12594.

Given the limitations of any potential reservoir size on Lot 1 DP 12594, and the lack of available cultural offset sites to mitigate adverse effects identified by MTA, Lot 1 DP 12594 is not considered to be a feasible location for the required water supply reservoir.

Lot 1 DP 591637, 416 Gladstone Road

This property is approximately 95 ha and is bounded on the north-western side by the Ohau River and on the north-eastern side by the Makaretu Stream and is accessed from Gladstone Road via a private bridge across the Ohau River.

An assessment of aerial photography and contour information indicates that there are two potential reservoir sites on this property being relatively flat land with no obvious (from aerial photography) wetland areas. Both of these sites are in the order of 10-12 ha and therefore of similar size to the proposed reservoir. One of the potential sites has several watercourses (which may or may not be ephemeral based on aerial imagery) running through it, which would need to be diverted in order to construct a reservoir. The second potential site however does not appear to be encumbered by watercourse features.

This area was not assessed in detail in the draft COMP, but was identified as potentially having good opportunities for offsetting cultural effects.

A further consideration is that any reservoir site needs to have access to a suitable intake site on the river in order for water to be abstracted to fill the reservoir. In order to give effect to requirements under the Water Services Act 2021 to identify and manage source water risks, HDC is seeking to abstract water for the reservoir from a source which is as pristine as possible. That is, an intake site at or just below the downstream extent of the Conservation Estate is sought given that Horizons One Plan requires water within the Conservation Estate to be managed for Natural State values (One Plan Schedule RP-SCHED2). Natural State water, or as near as possible to natural state, is

also required to manage and maintain water quality within the reservoir (i.e. to avoid degradation of stored water quality that could occur if lower quality source water were stored).

Therefore, a reservoir to be sited on Lot 1 DP 591637 would require an intake to be located on the Makaretu Stream, and not on the main branch of the Ohau River. There is no hydrological record for the Makaretu Stream and therefore it is difficult to assess the amount of water which would be available for abstraction here. However, a catchment size comparison can be made with the Ohau River. Both the Ohau (at the proposed reservoir intake site) and the Makaretu Stream source their water from a similar area of the Tararua Ranges within the Conservation Estate, with similar topography and ground cover and are therefore likely to have a similar rainfall-runoff pattern. The catchment size at the proposed reservoir intake site on the Ohau River is approximately 180 km^2. The Makaretu Stream has a catchment size of approximately 23 km^2, or less than 15% of the Ohau River catchment size. The Makaretu Stream is therefore extremely unlikely to provide sufficient water for the purposes of filling the reservoir.

The hydrology assessment for the proposed abstraction at the Ohau River reservoir intake site found that the effect of the 7,500 m^3/day core allocation abstraction from the reservoir site is less than 10% change in flow statistics and the scale of these changes is consistent with the flow regime change at the existing intake under the current consent. If this amount of water were to instead be taken from the Makaretu Stream, being a stream with a catchment site of less than 15% of the Ohau River site, significantly greater and likely more than minor effects on the hydrology of the Makaretu Stream would be expected.

Further, the hydrology assessment also found that the supplementary allocation sought equates to 10% of the river flow of the Ohau at the reservoir intake site for flows from the median flow up to the 25th percentile flow. Above the 25th percentile flow, the supplementary allocation sought is less than 10% of the river flow (decreasing as the river flow increases). As with the above, if the intake were to be located on the Makaretu Stream, being a much smaller water course, the supplementary allocation One Plan policy limit of 10% of the river flow would mean that there would be insufficient water in the supplementary allocation to supply the reservoir.

The reservoir is therefore unable to be located on Lot 1 DP 591637, due to the lack of a suitable size river and intake site from which to abstract water to fill the reservoir.

The WSAOF identified that there were three potential sites for the reservoir that could meet the source water needs for Levin Taitoko Water Supply. Of these three:

- Lot 9 DP 555714, being HDC owned land on Poads Road provides sufficient land for the reservoir, has access to a suitable reservoir intake site on the Ohau River at the exit of the Conservation Estate which can provide sufficient water to fill the reservoir, and includes a suitable and sufficient area to enable mauri and habitat enhancement to offset the cultural effects of the abstraction.
- Lot 1 DP 12594, is adjacent to the Ohau River and has a suitable intake site as per the HDC owned property, but it does not have sufficient flat land close to the Ohau River to enable a suitable size reservoir to be constructed, nor does it include a site on which cultural offsetting can be undertaken.
- Lot 1 DP 591637 is located on the Makaretu Stream. It has two sites which would be of sufficient area for a reservoir to be constructed, and also has land on which cultural offsetting could be undertaken. However, the Makaretu Stream is not of sufficient size to enable the abstraction for the reservoir without having significant adverse effects on the hydrological regime and life supporting capacity of the Stream.

Lot 9 DP 555714 is therefore the only available site for the reservoir.

3.2 Size of Reservoir

Having established that Lot 9 DP 555714 is the only available site for the reservoir, consideration must be given as to whether the reservoir needs to be of such a size that the marginal natural inland wetland is affected.

A summary of the water demand projections for the Levin water supply, as detailed in the WSAOP report is as follows:

- Due to increased growth in Levin, additional water supply is needed prior to the current consent's expiry date of 2042.
- If bulk storage is provided and network management/leakage reduction improvements (as described in the WSAOF report) are maintained, the existing consent only provides sufficient water through to 2039 based on the 95th percentile growth projections. (This is reduced to 2034 if network management and leakage improvement is not maintained).
- An alternate water source and/or off-river storage is required to improve the resilience of the supply against both drought and high-flow high-turbidity conditions in the Ohau River. To provide an effective drought response for a 1:50-year drought event, storage of 500,000 m^3 (at average daily water demand) - 700,000 m^3 (at peak daily water demand) is required.
- Post-emergency supply provisions would require bulk storage to provide for up to 30 days of supply at average demand (being 480,000 m^3 by the current consent expiry date of 2042 and 1,000,000 m^3 by the 50-year planning time frame of 2072).

HDC commissioned Damwatch to prepare a feasibility study of a 740,000 m^3 reservoir at the Poads Road site. As already discussed, and indicated in Figure 1, the development footprint of this reservoir includes the area of the Natural Inland Wetland identified by Wildlands in 2023.

Earthworks for reservoir construction within 100 m of this natural inland wetland may be granted consent as a Discretionary Activity provided there is a functional need for the reservoir in that location.

Should the north-western boundary be shifted to avoid earthworks within 100 m from the natural inland wetland, this will reduce the reservoir volume available and impact the resiliency of supply.

To assess the functional need for the size (and footprint) of the reservoir as designed, an assessment has been made to estimate the reduction in reservoir volume that could be expected by shifting the north-western boundary by 100 m away from the natural inland wetland, as shown in Figure 3.

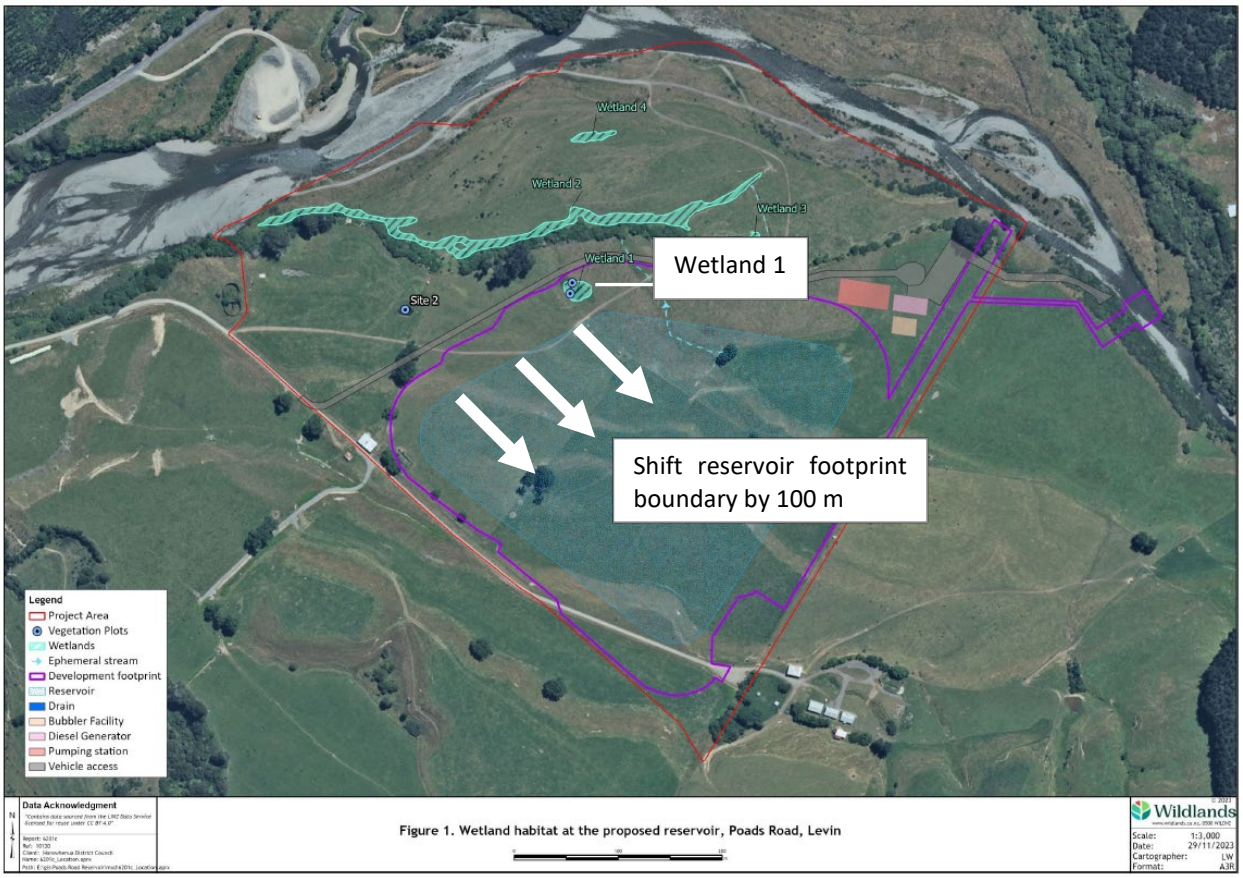


Figure 3: Estimation of Reservoir Volume Reduction by Shifting Boundary by 100m Away from Wetland 1

The preliminary design parameters from the Damwatch Feasibility Design Report are shown below in Table 1.

Table 1: Preliminary Design Parameters of Proposed Reservoir
Source: Feasibility Design Report prepared by Damwatch (2023)

Parameter	Value
Full Supply level	130.9 m RL
Lowest Level in pond base	120.0 m RL
Depth of water at full level	10.9 m
Reservoir area at Full Supply Level	85,000 m^2
Reservoir area at pond base	50,200 m^2
Reservoir volume at Full Supply Level	740,000 m^3

For simplicity purposes for this assessment, the reduction in volume has been estimated by:

- Shifting the north-western boundary uniformly by 100 m towards the south-eastern boundary as shown in Figure 2 (i.e. the shape of the boundary has not changed).
- Approximating the surface area of the reservoir and undertaking an assessment of the change in volume (approximated area x average depth) that would result from the change in the north-west boundary.
- Undertaking a sensitivity test based on approximated areas to give a lower end estimate of volume reduction.

A 100 m setback of the proposed reservoir boundary from the Natural Inland Wetland will result in an approximate reduction in reservoir volume in the range of 210,000 - 280,000 m^3 (to give a storage volume of 460,000 - 530,000 m^3. This represents a 28 - 38% reduction of the volume of 740,000m^3 at Full Supply Level.

Implications of Reduced Reservoir Size

A reduction in volume in the reservoir will in turn reduce the number of days' supply that can be provided without needing to abstract from the Ohau River (when at or below minimum flow conditions or in times of high-turbidity), and would reduce the number of days of bulk water storage in an emergency.

Section 3.7 of the WSAOF identifies that HDC is seeking to achieve 30 days average water demand storage in order to provide emergency supply between an emergency response phase and restoration of normal supply. It found that:

- 480,000 m^3 of storage is required to meet this level of service up to the year 2042.
- Approximately 1 million m^3 of storage is required to meet this level of service up to the year 2072 (approx. 50-year timeframe).

The proposed reservoir (740,000 m^3) therefore has a life of approximately 35 years before the 30-day storage requirement is not met. Reducing the reservoir size to avoid the wetland would reduce the reservoir life to less than 20 years before the 30-day storage requirement is not met.

Section 3.8 of the WSAOF assessed storage requirements to avoid abstraction at times when the river is below minimum flow. It found that, to provide sufficient storage for a 50-year return drought event without abstraction from the river below minimum flow and with water restrictions in place, 730,000 m^3 of storage is required. Reducing the reservoir size to avoid the natural inland wetland would mean that abstraction from the river at times of minimum flow would still be required.

Further analysis undertaken in the AEE shows that with significantly improved water demand management, the 740,000m^3 reservoir as proposed could store sufficient water to provide for the 100-year return period drought (26 days below minimum flow) up until 2040. Reducing the size of the reservoir to an estimated 460,000 - 530,000 m^3 would only provide this drought resiliency for the next 1-2 years.

4. CONCLUSION

It has been demonstrated that there is a functional need for the 740,000 m^3 reservoir at Poads Road (Lot 9 DP 555714), as proposed by HDC and designed on a preliminary basis by Damwatch, as specified infrastructure in that location. This is because:

- Of the three potential reservoir sites identified in the WSAOF, the proposed site is the only one which has sufficient land for the reservoir; has access to a suitable reservoir intake site on the Ohau River at the exit of the Conservation Estate which can provide sufficient water to fill the reservoir; and includes a suitable and sufficient area to enable mauri and habitat enhancement to offset the cultural effects of the abstraction.
- If a smaller reservoir was to be constructed, such that the marginal natural inland wetland was avoided, there would still be a need to abstract from the river below minimum flow during drought events, and the reservoir would have a significantly reduced timeframe in which it could meet council's sought level of service of 30-days storage following emergency.

Appendix L

CULTURAL OFFSET MANAGEMENT PLAN

Levin / Taitoko Water Supply

Cultural Offsetting Management Plan
August 2024

Draft

This report is jointly authored by Horowhenua District Council and Muaūpoko Tribal Authority; Approved by MTA, September 2023

Issue: Draft, August 2024

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Appendices

Appendix A Ecological Assessments – Reservoir Site

1 INTRODUCTION & PURPOSE

The purpose of this Cultural Offsetting Management Plan (COMP) is to identify and specify how effects on the cultural values, including mauri and habitat of the Ohau Awa, arising from the Horowhenua District Council's abstraction for the Levin / Taitoko Water Supply will be managed.

1.1 Proposed Levin / Taitoko Water Supply Reservoir & Abstraction

The Horowhenua District Council currently abstracts water from the Ohau Awa (as authorised by resource consent ATH-1991006011.03 granted by the Horizons Regional Council) on an on-demand basis including the abstraction of up to 13,000 m^3/day when the awa is below its minimum flow[1]. In order to reduce the need to abstract water below minimum flow, provide for community growth, and to improve the resilience of the water supply scheme, the Council proposes to construct a new intake in the upper Ohau Awa and a large water supply reservoir adjacent to the Ohau Awa to enable a water harvesting regime to be implemented. This will enable water to be abstracted when the awa is above median flow and stored to supplement the water supply at times of high demand and / or when the awa is below minimum flow. The reservoir will enable the Council to significantly reduce, but not necessarily eliminate, its need to abstract water from the awa below minimum flow. The proposed abstraction regime is summarised below.

Table 1: Summary of Proposed Abstraction Regime

	Abstraction from Reservoir Intake Site	Abstraction from Existing WTP Intake
When the awa is above median flow. (Core + Supplementary allocations available)	Up to 10% of the flow (supplementary allocation) Plus up to 7,500 m^3/day as core allocation	Generally, in the order of 8,000 m^3/day as core allocation, but may be up to 15,409 m^3/day as core allocation subject to the total core allocation (combined reservoir intake site and existing WTP not exceeding 15,409 m^3/day).
When the awa is between minimum flow and median flow (Only core allocation available)	Up to 7,500 m^3/day	
When the awa is below minimum flow	No abstraction	Supply to community to be provided via use of the stored water in the reservoir as far as practicable. For extended low flow periods, some low flow abstraction may be required. HDC propose a tangata whenua group to enable engagement with tangata whenua as to how the balance between the use of stored water and awa abstraction will be made to meet the community's water demand. Highest level of community water restrictions is required to be in place and being actively enforced by HDC. If required to maintain supply to the community (i.e. if stored water is insufficient), up to 13,000 m^3/day may be abstracted from the awa.

1.2 Cultural Impact Assessment

HDC has engaged with Muaūpoko Tribal Authority in developing the water supply reservoir and new water take regime proposal and preparing the necessary resource consent applications. HDC commissioned MTA to undertake a Cultural Impact Assessment (CIA) for the new water take proposal

[1] *Minimum flow as specified in the Horizons Regional Council's One Plan (combined Regional Policy Statement and Regional Plan), being 820 L/s as measured at the Rongomatane gauging site (a short distance upstream of the current abstraction point).*

and advise on mitigation measures to address any cultural effects arising from the proposal and ongoing abstraction of water from the awa. The CIA is detailed in the report "Assessment of effect on Muaūpoko values - Proposed Taitoko Drinking Water Scheme", March 2023. The CIA report should be read in conjunction with this Cultural Offsetting Management Plan.

The CIA recognised the necessity for the project and expressed support for a more resilient water supply for Taitoko and the surrounding communities. This notwithstanding, the CIA found that:

> *"The proposed quantum of water taken from the Ohau Awa, especially at low flow will affect the mauri of the awa, other waterbodies and groundwater that are hydraulically connected to it. The impact on mauri will have adverse effects on Muaūpoko values which must be managed, positive actions must be undertaken to enhance the mauri of the Ohau Awa to offset for the effects the water take will have"*

The CIA further records that:

> *"holding an active role in the continual improvement of the environment will ensure our values, such as mana whakahaere and manaakitanga, can be provided for in a positive way that uplifts our mātauranga and our people. We are looking to create pathways and provide opportunities for decision-making and mahi for our people, whether that be in the planning, construction, kaitiakitanga or kaupapa taiao spaces."*

The CIA also records that capacity constraints limit the ability for authentic engagement and the broader Te Tiriti relationship with HDC and recommend that, to mitigate these adverse effects:

> *"Muaūpoko are supported in their role as kaitiaki of the Ohau Awa and the surrounding environment to build capacity and capability".*

1.2.1 Recommendation for a Cultural Offsetting Management Plan

The CIA recommends a range of mitigation measures; some of which are to be incorporated into the proposal by HDC as applicant-offered conditions of resource consent, and the remainder of which are to be addressed through this Cultural Offsetting Management Plan.

The CIA recommends conditions of consent which specify the purpose, process and requirements for preparing and implementing the COMP, the condition is largely the same as recommended by the MTA CIA with minor amendments for clarity which have been agreed to by MTA. The condition is:

Cultural Offsetting Management Plan

1. *The consent holder shall invite Muaūpoko Tribal Authority to prepare the Cultural Offsetting Management Plan.*
2. *The objective of the Cultural Offsetting Management Plan is to demonstrate how no net loss, and preferably a net gain, of mauri in the Ohau Awa including habitat availability are achieved through the implementation of offset activities*
3. *The Cultural Offsetting Management Plan shall include:*
    a. *Identification of an appropriately qualified person, approved by Muaūpoko Tribal Authority to oversee the Cultural Offsetting and the person's role and responsibilities.*
    b. *The process for selecting the offset site(s)*
    c. *A summary of the cultural values at the impacted site and offset site*
    d. *A monitoring framework that can measure the identified cultural values including mauri and habitat availability*
    e. *A summary of approaches needed to enhance mauri and habitat availability at the offset site to achieve a no net loss and preferably a net gain*
    f. *A description of the program of actions required to achieve the offset*
    g. *A description of the offset principles and how the offset will achieve the principles to guide the development of the cultural effects offset proposal*

4. *The consent holder shall adopt the Cultural Offsetting Management Plan and once adopted, provide the Plan to The Manager for certification that the Cultural Offsetting Management Plan contains the matters set out below.*

Cultural Offsetting Monitoring

5. *Once an offset site is secured, a baseline assessment shall be undertaken of the site in accordance with the Cultural Offsetting Management Plan monitoring framework*
6. *In the third and fifth years following the completion of the cultural offsetting works, monitoring in accordance with the Cultural Offsetting Management Plan monitoring framework shall be undertaken*
7. *In the eighth year following the completion of the cultural offsetting works, the offsetting measures shall be reviewed to ensure no net loss has been achieved. The review shall include:*
    a. *A summary of progress towards achieving a no net loss and preferably net gain of mauri and an assessment of progress in achieving the restoration objectives*
    b. *Confirmation of whether a no net loss or net gain of mauri and habitat have been achieved or are expected to be achieved.*
    c. *If required recommended additional measures to be implemented to achieve no net loss or net gain of mauri and habitat values.*
    d. *If a no net loss has not been achieved or is not expected to be achieved the Cultural Offsetting Management Plan shall be reviewed and new actions included to achieve no net loss or net gain of mauri and habitat values. The updated Cultural Offsetting Management Plan shall be provided to The Manager.*
8. *The Cultural Offsetting Monitoring shall be undertaken by an appropriately qualified person, approved by Muaūpoko Tribal Authority.*

HDC has adopted MTA's proposed conditions for a COMP and this document has been prepared to meet the above recommendations.

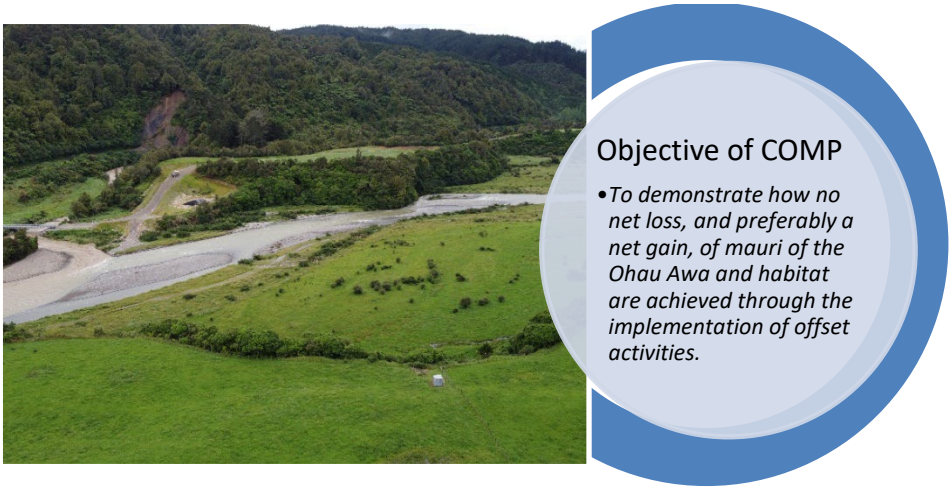
1.3 COMP Development & Endorsement

This COMP has been developed via a partnership between Horowhenua District Council (supported by Good Earth Matters Consulting Ltd) and Muaūpoko Tribal Authority (supported by Kahu Environmental Ltd).

The COMP has been presented to the Muaūpoko Tribal Authority Board for endorsement. Endorsement has been provided September 2023.

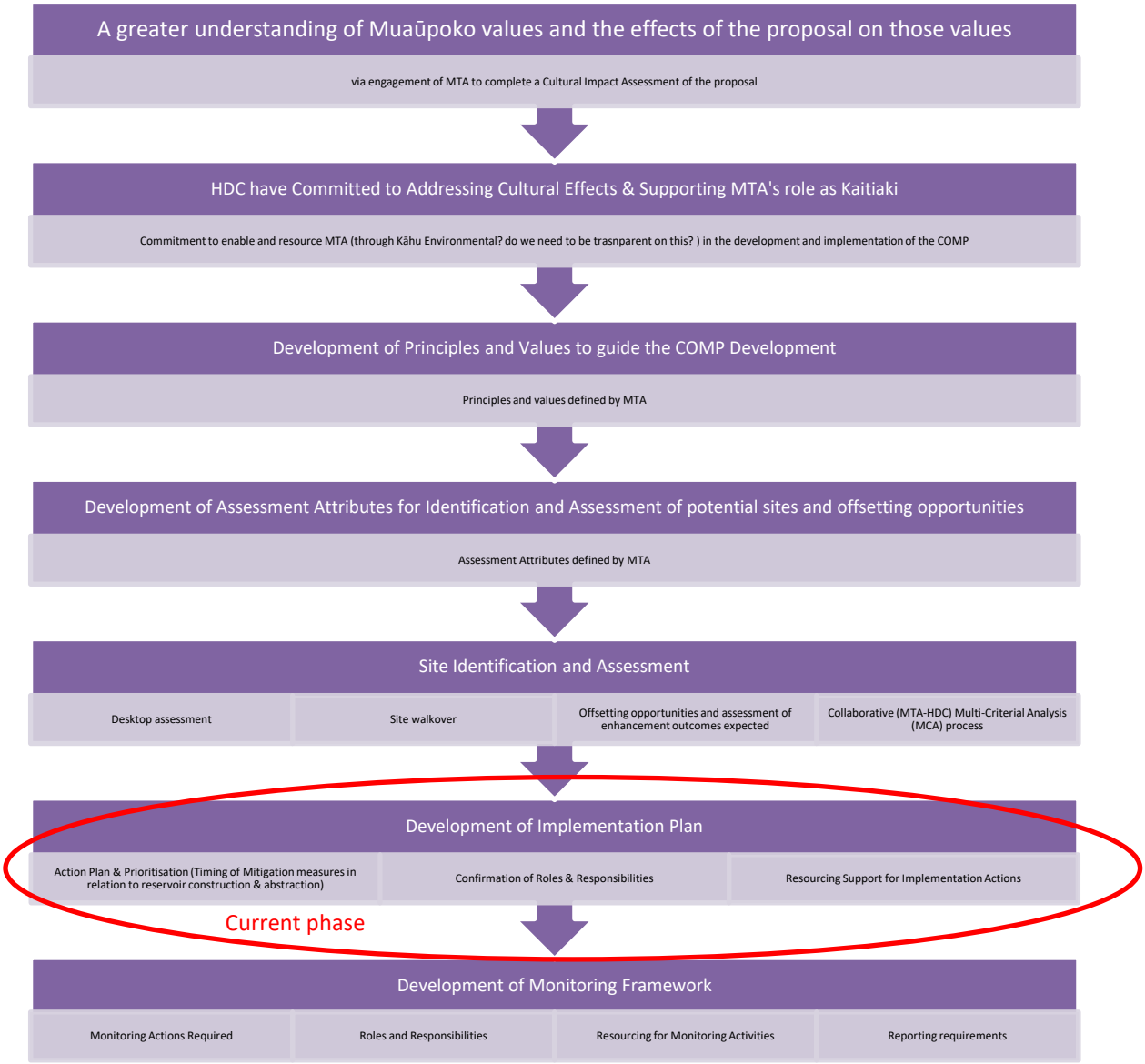
1.4 Objective of the COMP

As per proposed condition 2 above, the objective of this Cultural Offsetting Management Plan is:



2 PROCESS TO DEVELOPING COMP

The COMP is to be an MTA led process, supported by HDC as the local government body, water supplier and applicant. The following diagram summaries the process to developing this COMP.



2.1 Principles & Values

2.1.1 Net Loss Prior to Offsetting is not Required to be Quantified

From the findings of the CIA, and taking an RMA perspective, the Cultural Offsetting is predominantly required to address the effect of the proposed abstraction at times when the river is below or close to minimum flow, and also to give back to the waterbody from which wai is taken.

The abstraction of Levin Taitoko drinking water when the river is below minimum flow is currently authorised by the existing resource consent and HDC is obligated to exercise this abstraction when the river is below minimum flow in order to maintain water supply to the community, given that there is no bulk storage within the system. The proposed reservoir construction will significantly reduce HDC's reliance on the minimum flow abstraction. The Ohau Awa is understood to go below minimum flows very infrequently and, when it does, it does not generally remain in minimum flow conditions for

extended periods of time[2]. It is therefore expected that, with appropriate network management measures and water restrictions in place, there should not be a requirement to exercise the minimum flow abstraction except in significant periods of extended drought. However, it remains uncertain as to the extent to which the minimum flow abstraction will need to be exercised during the term of consent. Given the uncertainties remaining as to the rate of community growth and climate change impacts, a precautionary approach has been taken. Furthermore, when taking a Te Mana o te Wai approach, when we use resources, it is appropriate to give back to the environment from which they are taken.

HDC acknowledge that it is seeking consent to abstract water including below minimum flow which will have an adverse effect on cultural values and the mauri of the awa. The application for resource consent is proposing a "best endeavours" requirement to minimise the abstraction at times of minimum flow and a requirement to engage with tangata whenua prior to exercising that abstraction.

Given the infrequent nature with which the minimum flow abstraction will be exercised, and the proposed engagement with MTA to support its role as kaitiaki, it is considered that it is not necessary to invest significant time and resourcing into quantifying the extent of loss of values from water extraction and it is accepted that there are sufficient opportunities available to have confidence that they will result in a no net loss and that a net gain is achieved.

2.1.2 Principles for Offsetting

The following principles have been developed based on the "Guidance on Good Practice Biodiversity Offsetting in New Zealand (2014) document[3] and have been adopted for the project:

- Cultural values restoration actions are only used to offset the anticipated residual effects of project activities after appropriate avoidance, minimisation, remediation, and mitigation actions have taken place.
- Proposed restoration, enhancement and protection actions undertaken as cultural offsetting are additional to what would otherwise have occurred as part of this project or any other project.
- Offset actions are preferably undertaken within the vicinity of the Ohau Awa water take and must be undertaken alongside the Ohau Awa.
- The cultural values impacted by the project activities will be similar or the same as those enhanced in the offset location so that the overall result is no net loss, and preferably a net gain in cultural values.
- The positive cultural outcomes of the offset will last at least as long as the impact of the project, and ideally in perpetuity. The proposed Tangata Whenua Group (name to be confirmed) or delegated body will ensure that the positive cultural outcomes are maintained over the period of the project.
- The protection and restoration actions undertaken as a cultural offset are delivered or demonstrated prior to the adverse effects of the project occurring.

2.2 Potential Assessment Attributes

In terms of assessing the potential sites and opportunities for offsetting, the following Assessment Attributes have been identified.

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[2] *Historical records indicate an average of once in every 14 years, with the maximum consecutive days below minimum flow being 25 days.*

[3] *Guidance on Good Practice Biodiversity Offsetting in New Zealand; August 2014; Ministry for the Environment, Department of Conservation, Ministry for Primary Industries, Ministry of Business Innovation & Employment, Land Information New Zealand, New Zealand Government.*



3 SITES FOR CULTURAL OFFSETTING

The following describes potential sites along the Ohau Awa corridor where the water abstraction activity will be occurring. The sites are described below including any known information on cultural and ecological values as well as constraints and RMA planning information.

It was agreed between MTA and HDC that the primary study area would be the awa corridor between the new reservoir intake abstraction point on the upper Ohau awa, and Kimberley Reserve. The study area represents the portion of the awa which is closest to the location of the effects occurring and where there are likely significantly opportunities for enhancement, consistent with the principles identified above.

The study area including land ownership is shown in Figure 1. The following sections consider the study area in four reaches as follows:

1. The awa adjacent to the Water Supply Reservoir Site (from the new intake to Poads Road bridge). This area is all within HDC ownership.
2. The awa in the reach between Poads Road bridge and Gladstone Reserve. This area is within private ownership.
3. The awa from Gladstone Reserve to immediately downstream of the existing intake and Water Treatment Plant. The true right bank in this area is within public ownership and managed by HDC, and the true left bank is within private ownership.
4. The awa from immediately downstream of the existing Water Treatment Plant to Kimberley Reserve. This area is a mixture of public and private ownership.

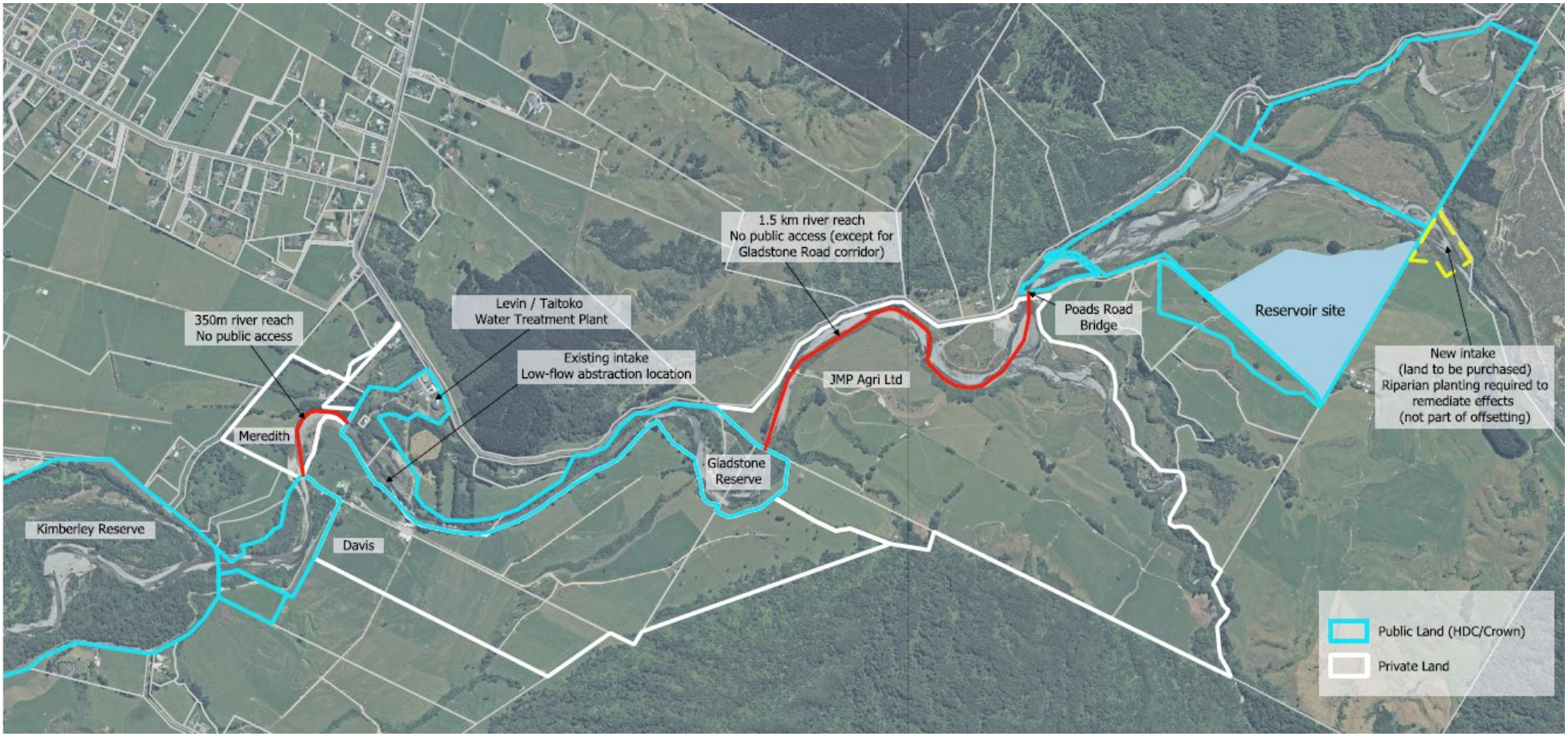


Figure 1: Study Area and Land Ownership

3.1 Horizons Regional Council One Plan Context

All sites are within the Horizons Regional Council's Ohau water management zone and the following values are specified in the Regional Policy Statement and Regional Plan (one Plan):

- Zone Wide Values (these apply to the entire zone):
  - Life supporting Capacity: Upland Hard Sedimentary for the Upper Ōhau (Ohau_1a) and Hill Mixed for the Lower Ōhau (Ohau_1b)
  - Aesthetics
  - Contact Recreation
  - Mauri
  - Industrial Abstraction
  - Irrigation
  - Stockwater
  - Existing Infrastructure
  - Capacity to Assimilate Pollution
- Site or Reach Specific Values. These apply to specific sites or reaches of the River as defined in Schedule B and listed below:
  - Site of Significance - Aquatic. This applies in the main stem of the Ohau River from the confluence of the Ohau River and Makahika Stream to approximately 600 m downstream of the existing intake site. It is valued for **redfin bully, bluegill bully and banded kōkopu**.
  - Amenity Value applies at the Gladstone Reserve site which is within the Existing WTP intake property described in section 3.3.
  - Trout Fishery - Other (i.e. not nationally or regionally significant) applies across the reach.
  - Trout Spawning value applies to the Makahika Stream and its tributaries (ie above the confluence of the Makahika Stream and Ohau River).
  - Water Supply. This value applies to the Ohau River above the existing intake site. It is set to protect the ability to abstract water and to protect the quality of the water for drinking water purposes because of the Levin / Taitoko Water Supply.
  - Domestic Food Supply. This value applies across the reach.
  - Flood Control and Drainage. This value applies to the main stem of the Ohau from downstream of the confluence with the Makahika Stream.

The enhancement activities adopted via this COMP seek to support and promote a range of these values, particularly those relating to mauri, life supporting capacity, contact recreation, and significant sites of aquatic value. Further, they have been developed and identified to ensure that the other values which are not specifically provided for, are not negatively affected and / or the achievement of those values is not frustrated.

3.2 Water Supply Reservoir Site

HDC own the property on which the water supply reservoir is to be constructed. The legal property boundaries extend well beyond the footprint area required for the reservoir including across the awa bed to the adjacent river riparian margins.

The property boundaries are shown in Figure 2 and an aerial photo of the site is included as Figure 3.

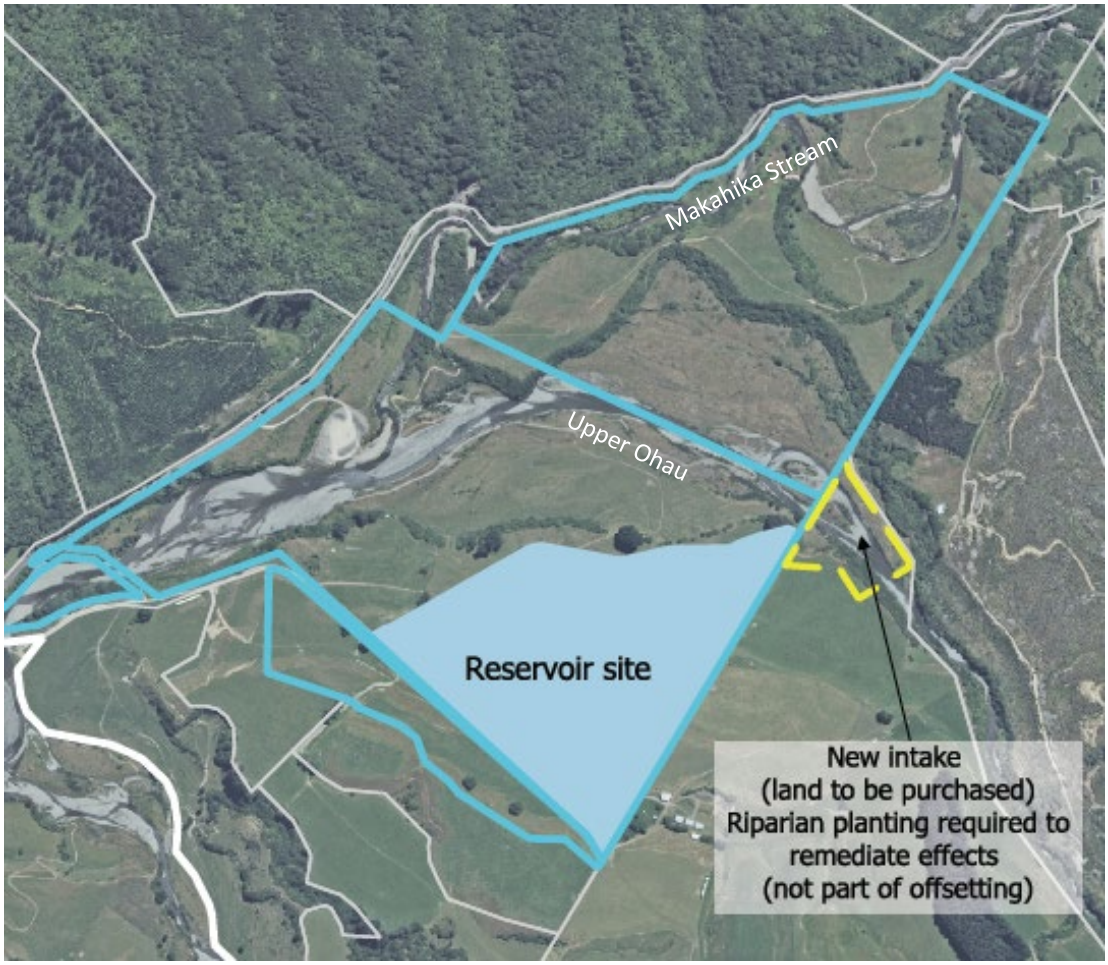


Figure 2: HDC Property Boundary and Reservoir Footprint Area



Figure 3: Aerial View of Site

The confluence of the Makahika Stream and Ohau Awa is located on this property.

The land owned by HDC which is not required for the water supply reservoir is shown in Figure 2 above. It comprises:

- A floodplain terrace on the true left of the active water channel of approximately 7.5 ha. This area is currently of limited ecological value, comprising exotic pasture and is grazed.

- At the base of the terrace between the reservoir site and the floodplain, there are several seepages / springs that have been observed on the terrace and a small watercourse forms which has connection to the awa. This is shown in Figure 4.



Figure 4: Intermittent Watercourse at Base of Terrace

The reservoir will have a groundwater under-drain which intercepts shallow groundwater below the base of the reservoir and it is proposed for this to be discharged to ground on the lower terrace. There is an opportunity to use this to enhance the headwaters of the watercourse on the lower terrace which could become new wetlands. The volume of groundwater intercepted will vary based on season but is estimated to range between 14 and 42 m^3/day (summer to winter variation).

The site is not currently accessible to the public. However, the lower terrace has easy access from the reservoir site and appropriate access is able to be constructed and maintained as part of the reservoir construction and maintenance, enabling access to any offsetting in this location.

The property extends across the river and there is easy access to the river terraces and river bed on the true right of the awa from Gladstone Road. Gravel extraction activities occur in this location, and this is the site of recent remediation works by HDC to secure Gladstone Road following slips in this area. HDC also own the land on the true right of the awa in this location.

The property would enable offsetting activities to be undertaken from approximately 150 m stream of the new reservoir intake site to the Poads Road bridge. HDC is currently negotiating with the owner of the immediately upstream property to purchase the portion of land on which the intake infrastructure is to be located. Subject to this purchase proceeding, there would be uninterrupted HDC ownership and access from the new reservoir intake site to Poads Road bridge, being approximately 1.5 km of the Ohau awa.

Known site-specific cultural and ecological values are:

- Cultural values – The area includes the confluence of Makahika and Ohau Awa. Confluences are important places for navigation and where mauri mixes. The area has large areas of gravel bar habitat important for taonga species and accessing the awa for cultural activities. The seepages are known as Kuha tī munga where water flows through and exits the aquifers. They are sources of pure water

and highly valued. The Kuha feed a small stream which is connected to the awa. The area has high potential for enhancement of cultural values.

- An ecological assessment of the reservoir site was undertaken in early 2022 by Wildlands and updated in May 2023 (as a consequence of changes to wetland definitions under the NPS-FM). That report identified the following features / values:
  - Vegetation along and in the vicinity of the terrace between the reservoir site and the lower floodplain comprises mixed indigenous broadleaves species forest (0.8 ha towards the centre and western end of the terrace); and mahoe treeland (0.2 ha) to the eastern end. Identified species are detailed in section 5.2 of the Wildlands ecological assessment report (Appendix A)
  - The ecological assessment report identifies the water seepages noted above as well as the watercourse at the base of the terrace. Wildlands have classified the watercourse as intermittent at the eastern (upstream) end and permanent at the western (downstream) end.
  - Three plant species which are classified as Threatened or At Risk were identified on the site. These were
    - Metrosideros diffusa (Threatened-Nationally Vulnerable).
    - Metrosideros fulgens (Threatened-Nationally Vulnerable).
    - Mānuka (Leptospermum scoparium agg; At Risk-Declining).

    Myrtaceae species have been assigned a national-level threat classifications because they are at risk of infection by myrtle rust (Austropuccinia psidii), a potentially devastating rust which has no known treatment (de Lange et al. 2018). Along with other species in the Myrtaceae family, the threat status of these species has been elevated as a precautionary measure based on the potential threat posed by myrtle rust, and they are not currently of conservation concern in this general area.
  - Pest plant species at the site include barberry, blackberry, cotoneaster, crack willow, gorse, lupin, and ornamental cherry (Prunus sp.). Barberry is common along the margins of Vegetation Type 1. Other pest plant species are not widespread and they could be easily controlled.
  - Fauna and Fish species as identified in the reports in Appendix A are shown below in Figure 5. Note that the fish species identified here are likely present at all study sites identified in this COMP.

Bird species recorded on 12 January 2021.

Common Name	Species Name
Indigenous Species	
Black-backed gull	*Larus dominicanus*
Grey heron	*Ardea cinerea*
Paradise shelduck	*Tadorna variegata*
Piwakawaka	*Rhipidura fuliginosa*
Pukeko	*Porphyrio melanotus*
Riroriro	Grey warbler, *Gerygone igata*
Semipalmated plover	*Charadrius semipalmatus*
Shining cuckoo	Pīpīwharauroa; *Chrysococcyx lucidus*
Silvereye	*Zosterops lateralis*
Swamp Harrier	*Circus approximans*
Tui	*Prosthemadera novaeseelandiae*
Welcome swallow	*Hirundo neoxena*
Australian magpie	*Gymnorhina tibicen*
Eastern rosella	*Platycercus eximius*
Blackbird	*Turdus merula*
Dunnock	*Prunella modularis*
Yellow hammer	*Emberiza citrinella*
Skylark	*Alauda arvensis*

Freshwater fish and large invertebrate species in the upper Ōhau River, from records in the New Zealand Freshwater Fish Database. Threat classifications for fish and large invertebrates are from Dunn *et al.* (2018) and Grainger *et al.* (2018), respectively.

Common Name	Scientific Name	Threat Classification	Number of Survey Records
Brown trout	*Salmo trutta*	Introduced	3–
Longfin eel	*Anguilla dieffenbachii*	At Risk - Declining	27
Redfin bully	*Gobiomorphus huttoni*	Not Threatened	23
Shortjaw kōkopu	*Galaxias postvectis*	Threatened - Nationally Vulne–able	15
Kōaro	*Galaxias brevipinnis*	At Risk - Declining	13
Upland bully (north)	*Gobiomorphus mataraerore*	Not Threatened	11
Torrentfish	*Cheimarrichthys fosteri*	At Risk - Declining	10
Kōura	*Paranephrops planifrons*	Not Threatened	6
Banded kōkopu	*Galaxias fasciatus*	Not Threatened	5
Lamprey	*Geotria australis*	Threatened - Nationally Vulnerable	2
Rainbow trout	*Oncorhynchus mykiss*	Introduced	–
Bluegill bully	*Gobiomorphus hubbsi*	At Risk - Declining	1
Common bully	*'obiomorphus cotidianus*	Not Threatened	1
Cran's bully (south)	*Gobiomorphus dinae*	Not Threatened	1
Goldfish	*Carassius auratus*	Introduced	1

Figure 5: Fauna and Fish Species Identified in Ecological Assessments

- The ecological assessment also identified stonefield features in the lower floodplain area that could provide suitable habitat for lizards. A lizard survey was undertaken, and no lizards were identified at that time.
- There were four "wet" areas identified and for which a wetland assessment under the National Policy Statement – Freshwater Management (NPSFM) was undertaken. Two of these areas are on the lower floodplain, one is on the upper terrace but outside of the reservoir footprint area and the fourth is within the reservoir footprint area. None of these sites were assessed as natural inland wetlands under the NPSFM however have potential to be restored with native vegetation and form natural wetlands over time.

  Note: Subsequent to the above assessment, Wildlands undertook a further assessment in November 2023 and revised their conclusions regarding natural inland wetlands. It was identified that there was one site within the reservoir footprint that could be classified as a natural inland wetland albeit a marginal classification and that site has little ecological value, is not ecologically significant and has little potential for ecological restoration. The revised assessment did, however, identify the wet areas and watercourse at the base of the terrace as being natural inland wetlands. The assessment found that the loss of the marginal wetland on the reservoir site could be offset by the restoration of the degraded wetlands on the lower terrace and this would "very substantially outweigh the minor adverse effects associated with the loss or modification of the small, highly modified 'marginal' wetland" on the reservoir site.

- The Te Araroa walking track passes around the perimeter of the property, running along Gladstone Road and then crosses the Ohau Awa at Poads Road and continuing along Poads Road adjacent to the reservoir.
- The District Plan has an aggregate extraction buffer zone which extends 200 m either side of the awa centreline and covers the area which is available at this site for cultural offsetting. The buffer zone restricts buildings in these areas but is unlikely to restrict cultural offsetting activities.
- The site is zoned rural in the District Plan with a Tararua Terraces Landscape Domain overlay, neither of which are expected to be constraints on cultural offsetting activities.

A further ecological assessment was undertaken by Wildlands to assess the effects of the construction and operation of the proposed intake site for the reservoir. Proposed works in this area include disturbance of the embankment, river terrace and riverbed. The effects of the construction and operation

are able to be effectively mitigated via suitable construction management plans and MTA will be engaged in that process through the recommended conditions of consent.

There will be some removal of vegetation on the river bank in the area of the proposed intake. The ecological assessment found that:

> *"removal of riparian vegetation along the left bank of the Ohau River will have minimal ecological effects due to the vegetation being composed of common plant species and extensive amounts of similar habitat being present within the immediate area. Even though the effects of this vegetation removal will be minor, a riparian planting programme to replace some of the vegetation removed with suitable indigenous species should be implemented".*

HDC will engage with MTA and seek advice as to suitable indigenous species and the proposed planting in this area. Riparian planting in the area of the intake structure is considered to be required in response to the removal of riparian vegetation to construct the structure and is therefore a remediation measure and is not to be considered as part of the cultural offsetting. This is in accordance with principle 1 identified above.

3.2.1 Opportunities for Enhancement

A site visit was undertaken by consultants representing MTA (Kahu Environmental) and Horowhenua District Council (Good Earth Matters Consulting) on 1 August 2023 to assess the site and identify, at a conceptual level, opportunities for enhancement. The outcomes of this site visit and a conceptual framework for enhancement at this site are shown in Figure 6.

It proposes that the overall COMP area be split into a series of Management Areas. **These management areas have been identified at a high level only at this stage and are subject to assessment by a restoration specialist and Muaūpoko kaitiaki, and confirmation of restoration objectives for each area**.

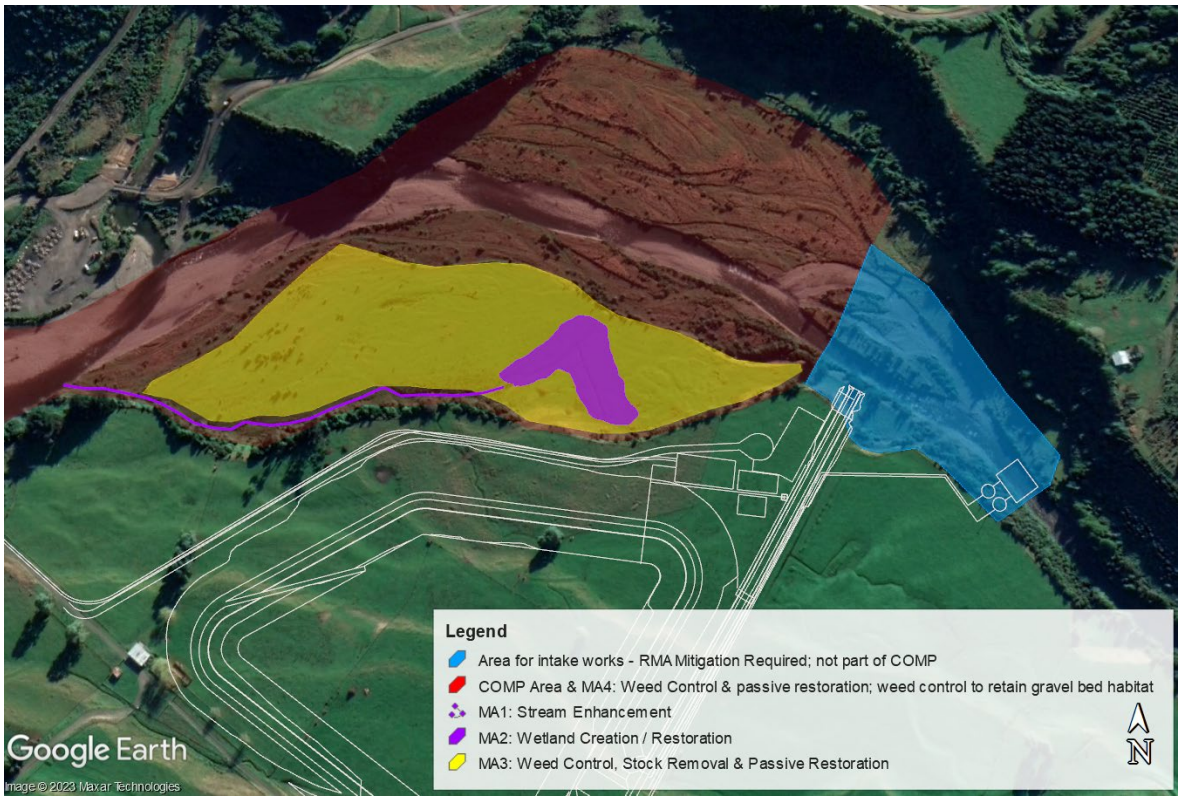
The general definition of the management areas is as shown in Figure 6 and discussed as follows:

- **Management Area 1: Stream Enhancement**
  This is the stream at the base of the embankment which has been identified in the ecological assessment of the site and shown in Figure 4 above. Restoration approach should include early / immediate removal of stock from the stream (to prevent further siltation of bed) and removal of litter; development and implementation of a planting and restoration plan, ensuring good connectivity to Ohau awa main stem is maintained.
- **Management Area 2: Wetland Creation / Restoration**
  This area currently includes a straight, artificial drainage channel which connects with the upper portion of the stream from Management Area 1. The channel here is eroded, primarily as a consequence of stock access. This is the area where the under-drainage from the proposed reservoir is intended to discharge diverted groundwater to land. There is an opportunity here to create a restored wetland area through stock exclusion, contouring of the eroded banks, utilisation of the diverted groundwater to maintain desired hydrology, and planting of wetland species. Development of the restoration plan for this area should be undertaken in parallel with the detailed design of the under-drainage system for the reservoir.
- **Management Area 3: Weed Control, Stock Removal and Passive Restoration**
  This area is the majority of the floodplain terrace which is currently grazed pastureland. This area provides an opportunity for passive restoration through weed control to manage invasive weed species; stock removal and manuka planting to establish vegetation cover and provide suitable conditions for passive restoration utilising the in-situ soil seed bank and natural transfer of seeds by birds. There are several log piles across this area. It is recommended that these be left in place to provide habitat (eg for lizards).
- **Management Area 4: Gravel Bed Habitat & Passive Restoration**
  This is the lower floodplain terrace and active river bed. A passive restoration approach is likely to be most suitable in this area and further assessment and advice is required as to the habitat type and restoration objective. On the vegetated areas, a restoration approach using species such as manuka and harakeke may be appropriate. On gravel bed areas, weed control is required to prevent loss of

the gravel bed habitat. As this is within the active river corridor, consultation with Horizons Rivers Management Team is required for activities in this area.

- There is also an opportunity for willow removal and harakeke planting on the true left of the awa closer to the Poads Road Bridge (between Poads Road and the river), subject to river protection works approaching the bridge are not impacted (i.e. closer to the bridge, exiting planting may be performing a bank edge protection function which would need to be assessed prior to any vegetation removal or disturbance in this area). This should be undertaken at the time that the pipeline works are undertaken in this area as mitigation for the proposed pipe works.

In addition to the above management areas, Figure 6 also identifies the area where riparian and river bed disturbance will be undertaken to construct the new intake works. This will be managed via the consent conditions for undertaking the works and in a way which involves MTA however are not part of this COMP as they are direct mitigation activities and not part of the offsetting activities.





Litter removal required in Management Area 1 (Stream Enhancement)



Eroded Channel Management Area 2 (Wetland Restoration)



Figure 6: Overview of Enhancement / Restoration Opportunities at Reservoir Site

3.3 Awa Corridor between Reservoir (Poads Road) and Gladstone Reserve

There is a stretch of approximately 1.5 km between the reservoir site and the public land which stretches from Gladstone Reserve to the Water Treatment Plant.

The majority of the true right bank of the awa in this stretch is road reserve (Gladstone Road), and includes an active consented gravel extraction area. The awa and its true left bank are in private ownership (JMP Agri Limited).

The District Plan zoning through this area is Rural with part of it being in the Levin-Ohau Landscape Domain overlay and part within the Tararua Terraces Landscape Domain overlay. None of these are expected to be constraints on cultural offsetting activities.

Existing cultural and ecological values in this reach are generally not well understood as this site has not been assessed in detail. Fish species likely to be present are those identified in Figure 5 above.

The site contains the confluence of Makaretu and Ohau awa. It contains large floodplain terraces that could have similar features such as small streams fed by freshwater springs. Some gravel bar habitat exists and some riparian vegetation.

This stretch has the benefit of being a long connecting corridor between the two sites from which the Levin / Taitoko abstraction will occur. Effects in this reach will arise from abstraction when the awa is above the minimum flow. Any abstraction when the awa is below minimum flow will occur at the existing WTP site which is downstream of this reach. Therefore, enhancement in this area and upstream may not directly mitigate effects of minimum flow abstraction however remains a good option for offsetting.

The private property boundary extends across the river bed, and includes a significant portion of the northern (true right) riparian edge. Gladstone Road runs on the northern side of the property and, in places the edge of the legal road reserve incorporate a small portion of riparian vegetation.

Opportunities for enhancement along this stretch will rely on the corporation and agreement of the private landowner. Examples of activities which could be encouraged / supported are the raupo wetland area which has already been protected on the JMP Agri Ltd land (refer Figure 7).



Figure 7: Raupo Wetland on JM Agri Ltd Property

3.3.1 Opportunities for Enhancement

- Engagement with private landowner to enable access to the site to assess opportunities for enhancement.
- Water supplier to commit to a best endeavours requirement to engage with the landowner and seek agreement to undertake riparian enhancement in this area, including understanding of, and support to meet, obligations to remove stock from river corridor and funding of planting or similar with a specified period of maintenance commitment.
- Engage with aggregate extractors in this area to better understand the extent of activity and effects and work with those extractors to encourage further mitigation or enhancement activities. Consent for this activity has expired and an application has been lodged to renew the gravel extraction consent (to take up to 10,000 m^3 of gravel from the awa at Gladstone Road). Processing of that consent application is currently on hold.

3.4 Existing WTP Intake Site

The existing WTP intake site is another potential site for cultural offsetting. This intake site is located approximately 3km downstream of the Poads Road bridge (being the downstream extent of the reservoir site property). The legal property on which the intake is sited and which is in public ownership extends upstream to Gladstone Reserve, only approximately 1.5 km downstream of the reservoir property. The location of the intake is shown below in Figure 8.



Figure 8: Existing Intake Site and Legal Boundary of Property

The property includes Gladstone Reserve, the river corridor, a narrow riparian area on the true right bank between Gladstone Reserve and the WTP site and the WTP Site including all associated infrastructure.

The entirety of the property identified in Figure 8 is designated under the District Plan for the purpose of "Levin Water Treatment Plant", designation #D140. This designation provides RMA land use approval for activities consistent with the designation purpose (noting that an Outline Plan may need to be submitted).

The site's underlying zoning in the District Plan is Rural with a Levin-Ohau Landscape Domain overlay, neither of which are expected to be constraints on cultural offsetting activities.

The existing intake is a subsurface intake consisting of approximately 270 m of buried pipe laid along and underneath the same alignment as the river bed. HDC has consent for, and regularly undertakes, scarification of the river bed in this location to maintain the intake structure. The proposal will reduce the amount of water abstracted from this site on a day-to-day basis and this is expected to reduce the frequency of riverbed disturbance for scarification.

The abstraction from the awa at times of minimum flow will occur at this site, and not at the reservoir site, and therefore this site is consistent with the principle of undertaking offsetting as close as possible to the location of the effect.

Existing cultural and ecological values in this reach are generally not well understood, as this site has not been assessed in detail. However, at a site visit in August 2023, it was identified that the riparian vegetation between Gladstone Road and the awa is well established (being a mix of exotic and indigenous species) and also that access and works in this area are likely to be difficult due to the narrow riparian strip and steep terrain / high embankments.

Fish species likely to be present are those identified in Figure 5 above. The site does not have large areas of gravel bar habitat, or potential for high habitat values of riffles, runs and pools.

Under the Regional Council's One Plan, the Gladstone Reserve portion of this site is valued for "amenity" purposes. The Gladstone Reserve site is managed by HDC in accordance with the Ohau River Reserves Management Plan (October 2017). It is a popular picnic spot and provides access to the river for swimming. There is also a public toilet in this area which is open over the summer period. The toilet has bunding around it to mitigate risk of flooding during a flood event.

The Council's Ohau River Reserves Management Plan (October 2017) states that:

> *"there is a potential opportunity to develop a pathway along the northern edge of the Ohau River … This path could initially be contained within Gladstone Reserve, with the possibility to extend it and create a shared pathway network connecting all of the Ohau River Reserves in the future.*

Consideration would need to be given as to whether this could result in any health and safety concerns in relation to the Levin water extraction, treatment and storage area and if so, how these would be addressed."

"Another opportunity is to develop a planting plan for this Reserve.. to help make it a more attractive space."

The Reserves Management Plan states that the vision for Gladstone Reserve is "to manage and develop the recreation part of Gladstone Reserve as a passive recreation space for the community to use and enjoy, whilst maintaining the natural and ecological values of the whole Reserve". Actions taken to achieve this vision are therefore not to be considered offset actions under this COMP.

3.4.1 Opportunities for Enhancement

- Planting or enhancement opportunities at the actively managed Gladstone Reserve area and development of walkway along this corridor will occur under the Council's Reserves Management portfolio and are therefore not considered to be offset activities.
- Council is undertaking a Master-planning process for their WTP site focused on treatment and capacity improvements. Coincident with this work, there is an opportunity for this planning to also consider:
  - Improvements / modifications at the Water Treatment Site which would enable the health and safety concerns raised in the Reserve Management Plan to be addressed and to provide a safe pathway through the treatment plant area such that HDC, as water supplier, enables the broader wider vision of a connected pathway along the Ohau awa corridor. This may include appropriate fencing of the treatment plant area (if not already in place) to ensure that safe access past the treatment plant area can be achieved.
  - Riparian enhancement through the Water Treatment Site. This has the benefit that the enhancement is occurring at the same site as the low flow abstraction would occur.
  - Developing a greater understanding of the effects of scarification at the existing intake site and identify opportunities to reduce those effects and / or undertake specific mitigation or offset activities to address those effects.

3.5 Downstream of WTP Intake Site

From the WTP site, the river has a 350 m stretch where it passes through private property before reaching Kimberley Scenic Reserve. It has an underlying zoning in the District Plan of Rural with a Levin-Ohau Landscape Domain overlay, neither of which are expected to be constraints on cultural offsetting activities.

Existing cultural and ecological values in this reach are generally not well understood, as this site has not yet been assessed in detail, however aerial photographs indicate high cliffs and well established riparian vegetation in places. Fish species likely to be present are those identified in Figure 5 above.

This area is shown in Figure 9.



Figure 9: Area between WTP Intake Site and Kimberley Reserve

While potentially challenging from an access and ownership perspective, this is the stretch of the river which will experience the most immediate effects of abstraction when the river is below minimum flow.

3.5.1 Opportunities for Enhancement

It is considered that enhancement opportunities in this area are limited and this site is not preferred for offsetting activities.

The Kimberley Scenic Reserve is a well vegetated stretch of the river corridor, held in public ownership and zoned Open Space in the District Plan. The reserve is a popular recreational area used for access to the river, swimming, and camping during the summer season. Kimberley Reserve is described in the Council's Ohau River Reserves Management Plan (October 2017) as having native and exotic flora and fauna which are unique to the reserve but require protection from invasive pest species. The reserve also provides habitat for native snail *Powelliphanta traversi*.

One of the management principles is to "maintain and preserve the Reserve's natural and recreation qualities as well as its value as a scenic reserve". As stated above, it has been agreed that the identification of enhancement opportunities does not need to extend into Kimberley Reserve area.

3.6 Assessment of Enhancement Opportunities

An assessment has been undertaken of enhancement opportunities identified above against the principles and assessment attributes identified in Section 2. The assessment is provided below.

This MCA is based on a traffic light style assessment. *Ranking from 1 to 5, with 5 being good; 3 being average; 1 being poor.*	Existing cultural and ecological values: Strength and diversity	Ability to promote ki uta ki tai or connectivity from mountains to sea	Range of Opportunities the location has for ecological and cultural revitalisation	Role / importance of the site in the health, functioning and potential benefit to the mauri of the Ohau awa	Range of constraints in achieving the projects objectives (slip hazards, access, land ownership)	Timeframes required to achieve outcomes or benefits	Ability to achieve a net gain in mauri and habitat values	Ability to implement passive restoration approaches	Total Score	Rank
Water Supply Reservoir Site										
Riparian planting is required in the area of the new reservoir intake to replace, and improve the quality of, vegetation which is removed in order to provide for infrastructure. This is considered a mitigation measure and will be required as a condition of consent. While necessary, it does not count towards mauri enhancement in response to adverse effects of the abstraction activity. This work is required to be done at the time of construction with maintenance for a sufficient period in order to ensure vegetation is well established	Not an offsetting action: This is required to mitigate construction effects									
Enhancement of balance of site not required for reservoir. This includes active restoration in Management Areas 1 & 2 (Stream at base of embankment and wetland creation utilising diverted groundwater from underneath the reservoir) and passive restoration across the remainder of the site (including weed control & stock exclusion)	3	5	5	4	5	5	5	4	36	1
Riparian planting near Poads Road Bridge: Improve riparian vegetation via willow removal and harakeke planting (or similar) subject to not impacting on bank stability at or near the bridge abutments.	3	2	3	3	4	5	3	5	28	2
Awa corridor between Reservoir (Poads Road) and Gladstone Reserve										
Engagement with private landowner to enable access to the site to assess opportunities for enhancement	2	2	3	3	2	2	3	2	19	6
Water supplier to commit to a best endeavours requirement to engage with the landowner and seek agreement to undertake riparian enhancement in this area, including understanding of, and support to meet, obligations to remove stock from river corridor and funding of planting or similar with a specified period of maintenance commitment	2	2	4	3	2	2	3	2	20	5
Engage with aggregate extractors in this area to better understand the extent of activity and effects and work with those extractors to encourage further mitigation or enhancement activities.	2	3	4	4	3	3	4	3	26	3
Existing WTP Intake Site										
Planting or enhancment opportuntiies at the actively managed Gladstone Reserve Area and development of walkway and ripairan planting	Not an offsetting action: This activity is already proposed and provided for within the Council's Ohau River Reserves Management Plan									
Improvements / modifications at the Water Treatment Site as part of the WTP Masterplan works and development of the sites. This could include actions to enable the health and safety concerns raised in the Reserve Management Plan to be addressed and **to provide a safe pathway t**hrough the treatment plant area such that HDC, as water supplier, enables the broader wider vision of a connected pathway along the Ohau awa corridor; riparian enhancement thorugh the site and develop a greater understanding of the effects of scarification at the existing intake site and identify opportunities to reduce those effects and / or undertake specific mitigation or offset activities to address those effects	2	3	3	4	3	2	4	1	22	4
Downstream of WTP Intake Site										
Assessment of site in general - specific enhancment opportunities considered limited.	3	3	3	3	1	1	2	1	17	7

Based on the above analysis, the preferred site, and the site which is able to give the greatest opportunity for net gain in mauri and habitat is the reservoir site and the offsetting approach outlines in Figure 6 of this report. The implementation plan set out in Section 4 below is based on the reservoir site being adopted as the preferred site for offsetting activities, but includes an action to consider the other opportunities for enhancement identified in sections 3.3 and 3.4 of this report if considered appropriate and desirable.

4 IMPLEMENTATION PLAN

4.1 Roles & Responsibilities

Roles and responsibilities for the implementation of this COMP are generally as follows and will be refined further as the COMP is developed.

Horowhenua District Council

The COMP will be required as a condition of consent for the Levin Taitoko water supply and, as consent holder and water supplier, HDC will be responsible for ensuring that the COMP is implemented and that offsetting activities are undertaken which provide for a net gain benefit. HDC has responsibilities under this COMP as follows:

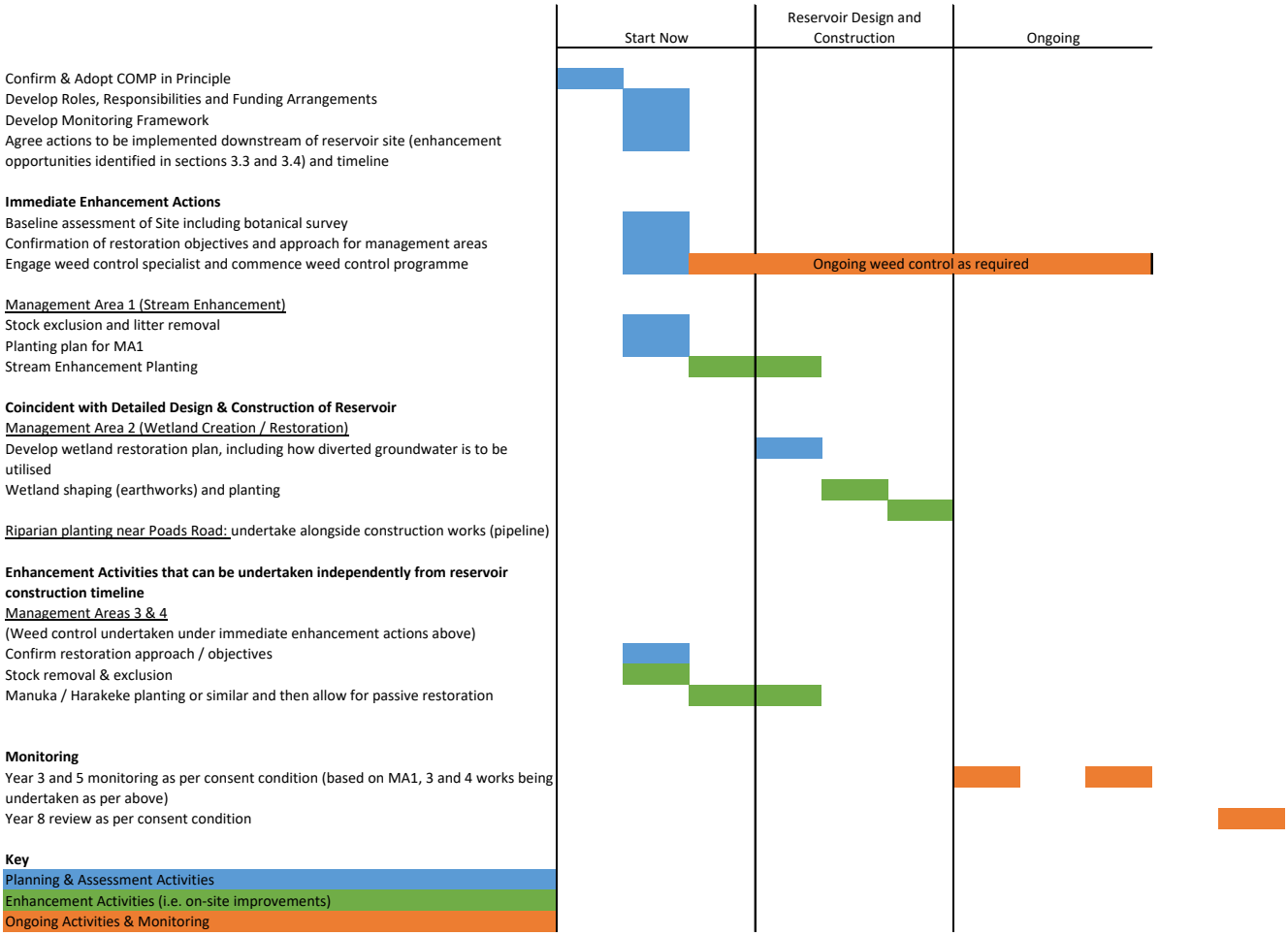
- Responsible for ensuring delivery of the COMP implementation objectives;
- As landowner of the reservoir site identified as the preferred site for offsetting activities, is responsible for providing access for offsetting activities including assessments, implementation and monitoring;
- Engagement of an appropriately qualified person to oversee the cultural offsetting (as per consent condition) and obtaining MTA approval for this person;
- Provision of funding and resourcing to enable the offsetting activities to be implemented and monitored, including funding and resourcing to support MTA's role as kaitiaki as it relates to the COMP activities;
- Ensuring coordination and engagement between HDC, its designers and contractors and MTA through the reservoir design and construction phases where these activities are inter-related;
- Entering into mutually agreeable contracts with MTA for the implementation of the offsetting activities including but not necessarily limited to development of restoration plans, planting and monitoring of outcomes.

Muaūpoko Tribal Authority

- Nominating a representative as key point of contact for this COMP
- Providing advice, support and approval for the COMP activities proposed, including the implementation plan and processes for implementation and monitoring.
- Approval of appropriately qualified person to oversee the cultural offsetting.
- Advice and support to ensure appropriate tikanga and cultural protocols are followed.
- Undertaking offsetting activities as agreed and engaged by HDC.
- Providing oversight of the COMP implementation.

4.2 Programme for Cultural Offsetting Activities

An initial programme for the proposed offsetting activities is presented as follows:



4.3 Monitoring Framework

As per the recommended consent condition, a monitoring framework is to be developed that can measure the identified cultural values including mauri and habitat availability.

This will include, but not be limited to:

- A baseline assessment of the restoration site and downstream of the WTP
- Monitoring to occur in year 3, year 5 and year 8 following offsetting works.
- In year 8 after the offsetting works, a review shall be undertaken which will include:
  - A summary of progress towards achieving a no net loss and preferably net gain of mauri and an assessment of progress in achieving the restoration objectives.
  - Confirmation of whether a no net loss or net gain of mauri and habitat have been achieved or are expected to be achieved.
  - If required recommended additional measures to be implemented to achieve no net loss or net gain of mauri and habitat values.
  - If a no net loss has not been achieved or is not expected to be achieved the Cultural Offsetting Management Plan shall be reviewed and new actions included to achieve no net loss or net gain of mauri and habitat values. The updated Cultural Offsetting Management Plan shall be provided to The Manager.

The monitoring shall include three aspects

1. A cultural health monitoring framework that will be undertaken by MTA. Its objective will be to monitor the mauri of the awa.

2. A stream ecological habitat evaluation (SEV) will be undertaken by an appropriately qualified ecologist. The objective is to monitor ecological functioning including habitat in the stream.
3. The MCI data collected in the SEV will be recalculated using flow-based methodology to understand if the aquatic community is impacted by flow.

Appendix A

ECOLOGICAL ASSESSMENTS – RESERVOIR SITE

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STAGE 1 ECOLOGICAL ASSESSMENT FOR A PROPOSED WATER STORAGE RESERVOIR AT POADS ROAD, LEVIN



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STAGE 1 ECOLOGICAL ASSESSMENT FOR A PROPOSED WATER STORAGE RESERVOIR AT POADS ROAD, LEVIN



Contract Report No. 6201

January 2022

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APPENDIX

1. Vascular plant species recorded at Poads Road water storage project area, January 2022 21

Reviewed and approved for release by:



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1. INTRODUCTION

Horowhenua District Council has identified the need to augment their current water supply and storage facilities for the Levin Water Treatment Plant. Good Earth Matters Ltd is preparing a resource consent application, on behalf of the District Council, to construct a new water reservoir and increase the currently consented water take from the Ōhau River.

The project will involve the construction of a new water reservoir at Lots 9, 10, and 11 between Poads Road and the Ōhau River, on a river terrace approximately six kilometres southeast of Levin (Figure 1). Water is to be provided to the reservoir from the Ōhau River via a new intake structure. An outlet structure is also to be installed downstream. The currently consented rate of water extraction from Ōhau River is 15,000 cubic metres (m3/s). Damwatch (2020) indicates that additional water will need to be taken from Ōhau River to future-proof the water supply and provide an acceptable filling rate for any proposed large water storage reservoir to meet the demand of the expected population growth in Levin.

On behalf of Horowhenua District Council, Good Earth Matters commissioned Wildland Consultants Ltd to undertake an initial site visit to identify ecological constraints within the proposed Poads Road Water Storage Reservoir project area.

2. ECOLOGICAL CONTEXT

2.1 Overview

The project area is located in Horowhenua District within the Manawatu Gorge South Ecological District, less than one kilometre east of the Manawatu Plains Ecological District.

Manawatu Gorge South Ecological District is part of the larger Manawatu Gorge Ecological Region. This Ecological District is located south of the Manawatu Gorge on a low elevated part of the Tararua Range. Key features of the Manawatu Gorge South Ecological District are set out below (from McEwen 1987):

- Climate: subject to prolonged westerly gales and low persistent cloud; typical rainfall range:1,400-4,000 mm per annum, evenly spread throughout the year with snowfalls in winter usually only remaining a few days.
- Geology: the hills and ranges present are largely Triassic-Jurassic greywacke, argillite, bedded alternating greywacke and argillite (0.01-1 metre thick beds), and breccia.
- Soils: hill and steepland soils are mainly derived of greywacke with small areas from Plio-Pleisitocene siltstone and sandstone; at lower altitudes and rainfall moderately leached and stable, used for pastoral farming or exotic forestry; at higher altitudes strongly to very strongly leached, often still in indigenous vegetation; soils from loess or drift material on easier slopes deeper, at lower slopes moderately

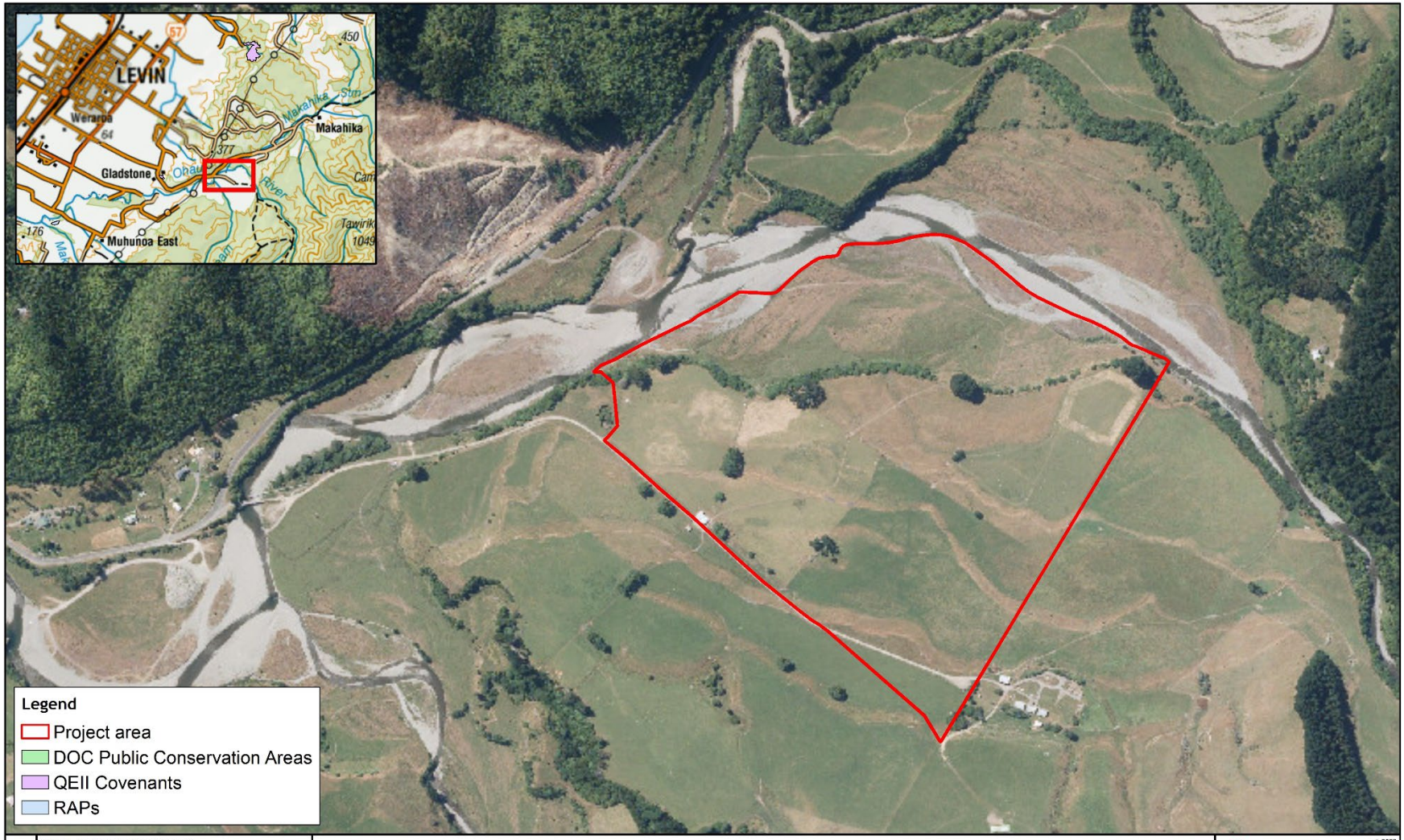


Figure 1. Location of the proposed reservoir, Poads Road, Levin.

leached with good drainage; at higher altitudes more strongly leached with impeded drainage and peaty topsoils.

- Manawatu Gorge South Ecological District has a total area of *c*.52,000 hectares (ha), of which *c*.15,200 ha (29%) is indigenous forest and a further *c*.11,000 ha (21%) is broadleaved indigenous hardwoods (source LCDB2). There are also other much smaller areas of other indigenous vegetation that comprise a further 2,000 ha (4%), and indigenous vegetation comprises, in total, 54 percent of the Ecological District.

2.2 Local context

The subject property is adjacent to the Ōhau River and near the Kohitere Scenic Reserve (*c.*165 metres to the north of the project area, on the other side of the Ōhau River). Ōhau Conservation Area and Tararua Forest Park are approximately one kilometre to the east of the project area.

The Ōhau River is part of the Ōhau_1 water management zone and the section of river adjacent to the project area is the 'Upper Ōhau (Ōhau_1a)' in Schedule B of the One Plan (2014). This section of the river is recognised as a site of Significant Aquatic Values in Schedule B of the Horizons One Plan (2014). Both the upper and lower Ōhau River sub-zones provide important habitat for redfin bully (*Gobiomorphus huttoni*, Not Threatened), bluegill bully (*G. hubbsi*, At Risk-Declining) and banded kōkopu (*Galaxias fasciatus*, Not Threatened) (One Plan 2014) (threat classifications are from Dunn *et al.* 2018).

2.3 Site description

The project area occupies a series of alluvial terraces adjacent to Ōhau River. Most of the project area is along the northern boundary of Poads Road, with a small (*c.*0.7 ha) area on the southern side of Poads Road. The land is currently used for grazing and is predominantly exotic pasture. There is a farm shed adjacent to Poads Road and no dwellings. The active Northern Ohariu Fault runs across the project area's northern margin of the project area, and the northern terrace of the project area is within the Horowhenua District Council Flood hazard area (Damwatch 2020). Damwatch 2020 identified the area in blue in Figure 2 for development of the Poads Road Water Storage Reservoir.

3. METHODS

3.1 Vegetation and habitat survey

The site was visited on 12 January 2022, during which time all vegetation and habitat types were mapped and described. Current ecological values of these vegetation and habitat types were also assessed. All vascular plant species observed were recorded and are presented in Appendix 1. Vegetation and habitat types were digitised onto aerial imagery using ArcGis10.7.

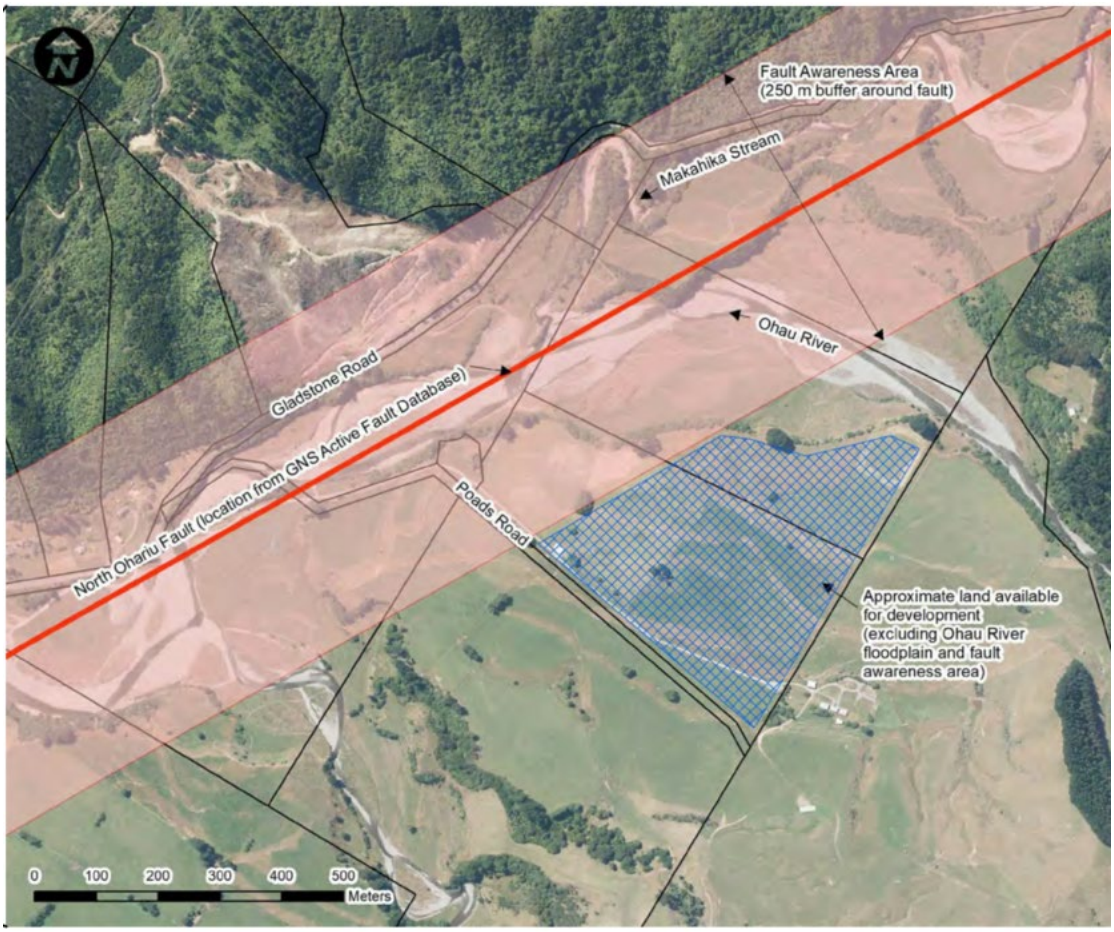


Figure 2: Land potentially available for development (as shown in blue) at the subject property. Source: Damwatch (2020).

3.2 Fauna survey

Targeted fauna surveys were beyond the scope of this report, however the suitability of the vegetation at the site to provide habitat for indigenous fauna species was assessed and all fauna species observed at the site were recorded.

4. STATUTORY CONTEXT

4.1 Overview

Information in this section has been included to provide an overview of the statutory context relevant to the potential ecological effects of the proposed activity, and is not an exhaustive overview. The following statutory documents are relevant:

- Horizons One Plan
- Horowhenua District Plan

- Resource Management Act 1991 (RMA) and National Policy Statement for Freshwater Management
- Wildlife Act 1953

4.2 Horizons One Plan

Policy 13-5 provides criteria for assessing the significance of habitats. Policy 13-5 refers to the rare, threatened, or at risk habitats defined in Schedule F of the One Plan and provides additional criteria that may also trigger a habitat being assessed as being significant, including:

(a) Representativeness

(b) The presence of threatened species, or species at their distributional limits

(c) Ecological connectivity and/or buffering

(d) Ecological sequences.

Habitat types in the Manawatū-Wanganui Region are identified and then assigned the following status categories developed by Mayseyk (2007):

(a) Rare: habitat types that were originally (pre-human) uncommon in the landscape and remain so

(b) Threatened: habitat types that have been reduced to 20% or less of former extent

(c) At risk: habitat types that have been reduced to 50% or less of former extent

(d) No threat category: Habitat where 50% or greater of former extent remains.

Schedule F of the Horizons One Plan details indigenous biological diversity types subject to protection within the Plan. A resource consent is required if the area is determined to be a habitat type classified as rare, threatened or at risk in Table F.1, it meets any of the criteria in Table F.2(a), and it is not excluded by any of the criteria in Table F.2(b).

4.3 Horowhenua District Plan 2015

Objective 3.2.1 (Indigenous Biological Diversity) in the District Plan requires the protection of significant indigenous vegetation and significant habitats of indigenous fauna. Policies 3.2.2 and 3.2.3 are key elements.

4.4 RMA and National Policy Statement for Freshwater Management

Wetlands are defined in the RMA (1991) as:

"Permanently or intermittently wet areas, shallow water, and land/water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions, including within the coastal marine area."

The National Policy Statement for Freshwater Management (NPS-FM) defines 'natural wetland' as a wetland (as defined in the RMA) that is not:

- A wetland constructed by artificial means (unless it was constructed to offset impacts on, or to restore, an existing or former natural wetland).
- A geothermal wetland.
- 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 water pooling derived from rain.

The prerequisite for a site to be classed as a natural wetland is for the area to meet the wetland definition under the RMA and not meet any of the exceptions under the National Policy Statement for Freshwater Management (NPS-FM). This definition requires suitable hydrological conditions and the presence of plants that are adapted to wet conditions. Areas identified as natural wetland under the NPS-FM are subject to regulations in the National Environmental Standards for Fresh Water (NES-FW).

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4.5 Wildlife Act 1953

All indigenous lizards, indigenous birds, and some indigenous invertebrates are protected under the Wildlife Act (1953). A permit under the Wildlife Act – a Wildlife Act Authority (WAA) – must be obtained from the Department of Conservation before any indigenous lizards and birds and/or their habitats can be disturbed, handled, translocated or killed. A WAA must be applied for and approved by the Department before activities affecting fauna may commence. This will require the submission of a species-specific management plan along with the permit application.

5. VEGETATION AND HABITATS

5.1 Overview

The project area covers *c.*28.7 hectares of mainly terraced pasture, most of which is exotic grassland. Other features on the site are:

- One intermittent stream.
- Two ephemeral streams channels, one of which has been straightened.
- Mixed indigenous broadleaved species forest and māhoe tree land on a hillslope.

Vegetation and habitat types are described below and are mapped in Figure 3.



Figure 3. Vegetation and habitat types at the proposed reservoir site at Poads Road, Levin.

5.2 Terrestrial vegetation and habitats

1. Mixed indigenous broadleaved species forest (0.8 ha)

This vegetation type occurs along the northern terrace. Māhoe (*Melicytus ramiflorus* subsp. *ramiflorus*) is common in this vegetation type up to 10 metres tall with scattered makomako (*Aristotelia serrata*), kōtukutuku (*Fuchsia excorticata*), tarata (*Pittosporum eugenioides*), kāmahi (*Weinmannia racemose*), lowland ribbonwood (*Plagianthus regius* subsp. *regius*), putaputawētā (*Carpodetus serratus*), and patē (*Schefflera digitata*) and one kaikōmako (*Pennantia corymbosa*) (up to 10 metres tall) is also present (Plate 2). Barberry (*Berberis glaucocarpa*) is common along the margins of this vegetation type with occasional cotoneaster (*Cotoneaster glaucophyllus*). *Muehlenbeckia australis* is locally common in the canopy and kareao (supplejack; *Ripogonum scandens*) and tātarāmoa (*Rubus cissoides* agg.) are scattered throughout. Epiphytes include *Metrosideros diffusa,* leather-leaf fern (*Pyrrosia elaeagnifolia*), kahakaha (*Astelia hastata*), *Asplenium flaccidum,* and *Asplenium polyodon.* The understorey is open with scattered rangiora (*Brachyglottis repanda*), *Coprosma rotundifolia*, kanono (*Coprosma grandifolia*) and *Coprosma propinqua* var. *propinqua*. Hangehange (*Geniostoma ligustrifolium* var. *ligustrifolium*) and indigenous tree ferns mamaku (*Cyathea medullaris*), ponga (*Cyathea dealbata*), and whekī (*Dicksonia squarrosa*). Ground cover along the upper bank comprises exotic grasses including sweet vernal (*Anthoxanthum odoratum*) and Yorkshire fog (*Holcus lanatus*) with local areas of blackberry (*Rubus fruticosus* agg.), foxglove (*Digitalis purpurea*), rārahu (bracken; *Pteridium esculentum*) and kōwaowao (hound's tongue fern; *Microsorum pustulatum*) common. The ground cover along the steep bank is dominated by leaf litter and scattered rocks with rereti (*Blechnum chambersii*) locally common on the steep banks and mouku (hen and chicken fern; *Asplenium bulbiferum*) present on the lower slopes. There are scattered water seepages along the lower section of the bank in this vegetation type.

2. Māhoe treeland (0.2 ha)

This vegetation type is present on the northeastern hillslope. Māhoe, up to eight metres tall, forms a discontinuous canopy over grazed exotic grassland, including Yorkshire fog and browntop (*Agrostis capillaris*) (Plate 3). *Muehlenbeckia australis* is common in the canopy with common leather-leaf fern and *Microsorum scandens* epiphytic on Māhoe. There is one porokaiwhiri (*Hedycarya arborea*) (up to five metres tall). Rangiora, barberry, and karamū (*Coprosma robusta*) are scattered in the understorey. Rārahu and blackberry are locally common in the understorey.



Plate 1: Mixed indigenous species broad leaved forest along northern terrace. 12 January 2022.



This vegetation type is grazed exotic grassland with Yorkshire fog, browntop, sweet vernal, creeping bent (*Agrostis stolonifera*), rye grass (*Lolium perenne*) and crested dogstail (*Cynosurus cristatus*) scattered throughout. Herb species present include; red clover (*Trifolium pratense*), white clover (*Trifolium*

repens), Californian thistle (*Cirsium arvense*), fox glove, narrow-leaved plantain (*Plantago lanceolata*), ragwort (*Jacobaea vulgaris*), sheep's sorrel (*Rumex acetosella*). There are scattered emergent barberry and blackberry along the road and fence margins. Water pepper (*Persicaria hydropiper*) is locally common along the bottom edge of each of the terraces with scattered *Juncus edgariae*, and soft rush (*Juncus effusus* var. *effusus*).

There are four discrete areas dominated by jointed rush (*Juncus articulatus*) with scattered Yorkshire fog, water purslane (*Ludwigia palustris*), lotus, soft rush, water pepper and *Isolepis prolifera*. Along the bottom of the northern terrace there are areas of water forget-me-not (*Myosotis laxa* subsp. *caespitosa*), water celery (*Apium nodiflorum*) and watercress (*Nasturtium officinale*) along the margins of the ephemeral stream as well as *Isolepis prolifera*, jointed rush and soft rush.

There are three small areas (*c.*0.01 hectares) of formed rock piles (piles of rocks that have been cleared from the paddock prior to cultivation/ploughing) on the terrace slopes, surrounded by exotic grassland. These areas of rocks contain scattered rārahu (bracken) and pōhuehue (*Muehlenbeckia complexa*).

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4. (Tutu)-(crack willow)/exotic grassland (1.8 ha)

This vegetation type is adjacent to the Ōhau River. Tutu (*Coriaria arborea* var. *arborea*) and crack willow (*Salix ×fragilis*) are scattered throughout emergent over rank exotic grassland and areas of exposed coarse alluvial gravel. Areas of alluvial gravel indicate the changing nature of the river bed and past flooding events (Plate 3). There are a few toetoe (*Austroderia toetoe*), lupin (*Lupinus arboreus*), gorse (*Ulex europaeus*), tauhinu (*Ozothamnus leptophyllus*), and barberry also present. This area appears to flood infrequently.



Plate 3: Emergent tutu and one toetoe over rank exotic grassland and areas of open coarse gravel. 12 January 2022.

5.3 Wetland habitats

There are about four areas of potential wetland habitat. During the survey one of these areas (Plate 4) had open water surrounded by jointed rush and scattered *Isolepis prolifera,* and soft rush. The remaining three potential wetland areas consisted of jointed rush, water pepper, water purselane, and locally common *Isolepis prolifera* surrounding open areas of dried or damp mud. Wetland delineation is required to identify whether these are 'natural wetland' as defined in National Policy Statement Freshwater Management (NPS-FM) in Section 4.4 above,.



Plate 4: Area of open water surrounded by jointed rush and exotic grassland. 12 January 2022.

5.4 Aquatic habitats

Watercourses at the site were assessed and classified using the RMA definition of river as adopted in the One Plan (2014): "continually or intermittently flowing body of freshwater" – meaning that intermittent streams (those that flow for part of the year) and permanently flowing streams are treated the same when assessing effects. In contrast, waterways that only flow for short periods following significant rainfall are not considered to be "rivers" from a planning perspective.

There is one permanent/intermittent stream within the project area and two ephemeral waterways.

The permanent/intermittent stream is located along the bottom of the northern terrace in the project area (Figure 2). The stream begins as an intermittent stream at the eastern (upstream) end and becomes permanent at the western (downstream) end as it is fed by approximately three water seepages along the steep bank. The eastern (upstream) section of the stream was not flowing with pools up to 15 centimetres deep sitting in the stream bed at the time of the survey. The western (downstream) section was flowing at the time of the survey. The entire permanent/intermittent stream is surrounded by wetland vegetation as outlined in Section 5.3. The width of the permanent/intermittent stream was up to two metres (Plate 5) with a substrate of deep soft mud and small areas of fine gravel. Only small sections of the stream were covered with a forested canopy, with most of the stream exposed.



Plate 5: Intermittent stream along the base of the northern terrace.
12 January 2022.

At the time of the site visit both ephemeral streams were dry. The ephemeral waterway on the lower terrace, closer to the Ōhau River, has a constructed (i.e. excavated) straight channel (Plate 6). The other ephemeral waterway on the higher terrace appears to have a natural channel. This waterway has species adapted to wet areas including water pepper and water purselane with areas of mud with deep cracking, which may indicate that it holds water for longer periods than an ephemeral waterway would (Plate 7).



Plate 6: Formed straight channel with no water present at the time of the survey. 12 January 2022.



Plate 7: Ephemeral flow path on upper terrace with water pepper and water purslane dominant around an area of mud with deep cracking. 12 January 2022.

6. FLORA

Fifty-one indigenous and 50 exotic plant species were recorded during the site visit (Appendix 1).

Three plant species recorded in the survey are classified as Threatened or At Risk (de Lange *et al.* 2018):

- *Metrosideros diffusa* (Threatened-Nationally Vulnerable).
- *Metrosideros fulgens* (Threatened-Nationally Vulnerable).
- Mānuka (*Leptospermum scoparium* agg; At Risk-Declining).

Myrtaceae species have been assigned a national-level threat classifications because they are at risk of infection by myrtle rust (*Austropuccinia psidii*), a potentially devastating rust which has no known treatment (de Lange *et al*. 2018). Along with other species in the Myrtaceae family, the threat status of these species has been elevated as a precautionary measure based on the potential threat posed by myrtle rust, and they are not currently of conservation concern in this general area.

Pest plant species at the site include barberry, blackberry, cotoneaster, crack willow, gorse, lupin, and ornamental cherry (*Prunus* sp.). Barberry is common along the margins of Vegetation Type 1. Other pest plant species are not widespread and they could be easily controlled.

7. FAUNA

7.1 Birds

Twelve indigenous species were recorded at the site along with eight exotic species (see Table 1 below). Of the indigenous species, none are classified as being of national conservation concern, i.e. classified as Threatened or At Risk as per Robertson *et al.* 2021.

Table 1: Bird species recorded on 12 January 2021.

Common Name	Species Name
Indigenous Species	
Black-backed gull	*Larus dominicanus*
Grey heron	*Ardea cinerea*
Paradise shelduck	*Tadorna variegata*
Piwakawaka	*Rhipidura fuliginosa*
Pukeko	*Porphyrio melanotus*
Riroriro	Grey warbler, *Gerygone igata*
Semipalmated plover	*Charadrius semipalmatus*
Shining cuckoo	Pīpīwharauroa; *Chrysococcyx lucidus*
Silvereye	*Zosterops lateralis*
Swamp Harrier	*Circus approximans*
Tui	*Prosthemadera novaeseelandiae*
Welcome swallow	*Hirundo neoxena*

Common Name	Species Name
Exotic Species	
Australian magpie	*Gymnorhina tibicen*
Eastern rosella	*Platycercus eximius*
Blackbird	*Turdus merula*
Dunnock	*Prunella modularis*
Yellow hammer	*Emberiza citrinella*
Skylark	*Alauda arvensis*

Records of recent observations (within the last five years) for the area in iNaturalist and eBird (on-line platforms for crowd-sourced observations of wildlife and birds, respectively) New Zealand Falcon (Threatened-Nationally Increasing, as per Robertson *et al.* 2021) have been recorded at this site in 2021.

Pukeko chicks were observed within the project area and piwakawaka, riroriro and silvereye were see foraging within Vegetation Types 1 and 2 indicating that the vegetation within the project area and wider area provides good habitat for breeding and foraging.

7.2 Aquatic fauna

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There are 45 fish survey records for the upper Ōhau River catchment recorded in the New Zealand Freshwater Fish Database, listing 15 species (Table 2) (Crow 2017, accessed January 2021). Twelve of these are indigenous. Twenty-nine of the records are from the last 14 years, making it a fairly up-to-date dataset.

Table 2: Freshwater fish and large invertebrate species in the upper Ōhau River, from records in the New Zealand Freshwater Fish Database. Threat classifications for fish and large invertebrates are from Dunn *et al.* (2018) and Grainger *et al.* (2018), respectively.

Common Name	Scientific Name	Threat Classification	Number of Survey Records
Brown trout	*Salmo trutta*	Introduced	3–
Longfin eel	*Anguilla dieffenbachii*	At Risk - Declining	27
Redfin bully	*Gobiomorphus huttoni*	Not Threatened	23
Shortjaw kōkopu	*Galaxias postvectis*	Threatened - Nationally Vulne–able	15
Kōaro	*Galaxias brevipinnis*	At Risk - Declining	13
Upland bully (north)	*Gobiomorphus mataraerore*	Not Threatened	11
Torrentfish	*Cheimarrichthys fosteri*	At Risk - Declining	10
Kōura	*Paranephrops planifrons*	Not Threatened	6
Banded kōkopu	*Galaxias fasciatus*	Not Threatened	5
Lamprey	*Geotria australis*	Threatened - Nationally Vulnerable	2
Rainbow trout	*Oncorhynchus mykiss*	Introduced	–
Bluegill bully	*Gobiomorphus hubbsi*	At Risk - Declining	1
Common bully	*'obiomorphus cotidianus*	Not Threatened	1
Cran's bully (south)	*Gobiomorphus dinae*	Not Threatened	1
Goldfish	*Carassius auratus*	Introduced	1

As all the streams in the project area are either intermittent or ephemeral, it is unlikely that there are resident fish. However, intermittent streams are often overlooked as important temporary feeding grounds for fish, with some individuals reliably moving into intermittent sections each time they fill with water. Indigenous fish species from

within the catchment that are likely to use intermittently available habitat are longfin eel (*Anguilla dieachi*, At Risk – Declining), banded kokopu, and koura (*Paranephrops planifrons*, Not Threatened). If parts of the intermittent stream retain water all year, such as close to the seepages, they may provide permanent habitat for these species.

7.3 Lizards

The currently known lizard fauna of the Manawatu Gorge South Ecological District includes ngāhere gecko (*Mokopirirakau* 'southern North Island'; At Risk - Declining) (Bell and Wiles 2015). However, the currently known lizard fauna from the neighbouring Manawatu Plains Ecological District (which is less than five kilometres from the proposed reservoir site) is more biodiverse, containing the following species in addition to ngāhere gecko: barking gecko (*Naultinus punctatus;* Risk - Declining), Raukawa gecko (*Woodworthia maculata;* Not Threatened–, goldstripe gecko (*Woodworthia chrysosiretica*; At Risk - Declining), northern grass skink (*Oligosoma polychroma;* Not–Threatened), glossy brown skink (*O. zelandicum*– At Risk - Declining), copper skink (*O. aeneum;* At Risk - Declining), ornate skink (*O. ornatum;* At Risk – Declining), and Kupe skink (*O*. aff. *infrapunctatum* 'southern North Island'; Threatened – Nationally Critical) (Bell and Wiles 2015). Historical records of Pacific gecko (*Dactylocnemis pacificus*) in the southern North Island are now attributed to Raukawa gecko. A population of the introduced plague skink (*Lampropholis delicata*) is also known from Foxton Beach (Department of Conservation 2021). The threat classification status for the species listed above are from Hitchmough *et al*. (2021).

A search of the Department of Conservation's Bioweb Herpetofauna Database (updated October 2021) found no herpetofauna records within the site. The lack of lizard records is likely due to a lack of dedicated lizard surveys in the area.

Lizard records from within a five-kilometre radius of the proposed reservoir site are listed in Table 3.

Table 3: Lizard species recorded within a five-kilometre radius of the proposed reservoir site, from records in the Department of Conservation Bioweb Herpetofauna Database and more recent work in the area by Wildland Consultants (2021). Threat classifications are as per Hitchmough *et al*. (2021).

Common Name	Scientific Name	Threat Classification	Number of Survey Records	Distance From Site	Date(s) of Survey Records
Ornate skink	*Oligosoma ornatum*	At Risk-Declining	3	c.3-5 kilometres	1976, 1994, 2020[1]
Ngāhere gecko	*Mokopirirakau* "southern North Island"	At Risk-Declining	1	c.3 kilometres	1990
Glossy brown skink	*Oligosoma zelandicum*	At Risk-Declining	1	c.3 kilometres	1965

[1] The most recent record of ornate skink (2020) is from survey work done in the surrounding area by Wildland Consultants (2021).

The areas of māhoe treeland, indigenous forest edges, and areas of exotic grassland that are not intensively grazed provide potential habitat for the terrestrial or semi-terrestrial lizard species copper skink, ornate skink, glossy brown skink, northern grass skink, and/or Raukawa gecko. Ornate skink, glossy brown skink, and copper skink are particularly associated with remnant indigenous forest and bush margins with adequate complex refugia (thick leaf litter, blackberry, rock or log piles). Sufficiently complex habitat for these species is present within the mixed indigenous broadleaved forest, māhoe treeland, and in the formed rock piles (Plate 8) and log piles present within exotic grassland (particularly those with pōhuehue). Uric acid secretions resembling older lizard faecal deposits were seen in rock piles in some of the rock piles during an opportunistic visual search (*c.*0.5 person-hours) on 12 January 2022, potentially indicating the presence of lizards.

While the (tutu)-(crack willow)/exotic grassland appears to contain microhabitats of sufficient complexity for these skink species, flooding may preclude these species being present in this habitat type. The indigenous forest and treeland also provides potential habitat for the arboreal and semi-terrestrial gecko species: Raukawa, ngāhere, and barking geckos.

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Plate 8: One of the rock piles in exotic grassland that may potentially provide habitat for terrestrial skinks. 12 January 2022.

7.4 Invertebrates

Surveys for invertebrates were not undertaken. *Powelliphanta traversi traversi* and *Powelliphanta traversi florida* (Threatened-Nationally Critical) are present in Kimberly Reserve and Waiopehu Reserve (only *Powelliphanta traversi*

traversi was found in Waiopehu Reserve) (Wildland Consultants 2021). Both these reserves are less than five kilometers from the project area. Both these species are found in areas of indigenous forest with moist leaf litter or understorey vegetation such as tradescantia. The mixed indigenous broadleaved species forest area does not have dense understorey vegetation and is unlikely to provide habitat for *Powelliphanta traversi traversi* and *Powelliphanta traversi florida*.

8. ECOLOGICAL VALUES

The three vegetation types mapped and described at the site were assessed for statutory significance under Policy 13-5 and Schedule F for habitats in the Manawatū-Wanganui Region. The significance of habitats due to the confirmed presence of common Myrtaceae species (e.g. mānuka) that are listed as Threatened has not been used as a trigger for significance, as the threat ranking considers a potential threat, and these species are still widespread and in places locally abundant.

Currently none of the habitats present within the project area are significant under Policy 13-5 and Schedule F. However, indigenous semi-arboreal and/or terrestrial lizards, including ornate skinks, copper skinks, glossy brown skinks (classified nationally as At Risk-Declining) and/or northern grass skinks (classified as nationally Not Threatened), could potentially be present in the areas of formed rock piles , pōhuehue, rank grassland, and blackberry within the project area. If lizard surveys identify populations of threatened lizard species then the associated habitats will be significant under Policy 13-5 (a) (ii) (A).

The Ōhau River is a Site of Significance-Aquatic (SOS-A), Trout Fishery (TF), Domestic Food Supply (DFS) in the One Plan (2014). The Ōhau River has a high diversity of indigenous fish of which the majority of species are migratory and require access to the sea for part of their lifecycle. There is also a good-sized population of the Threatened-Nationally Vulnerable, shortjaw kōkopu.

The four ‘wetland’ sites are all small and highly modified and require further evaluation.

9. ECOLOGICAL CONSTRAINTS

Key ecological constraints at the site proposed for the Poads Road Water Storage Reservoir include:

- Areas of formed rock piles in Vegetation Type 3 within the proposed area of the Poads Road Water Storage Reservoir may support significant populations of terrestrial lizards, which are protected under the Wildlife Act (1953). A lizard survey is required to determine whether indigenous lizard populations are present within the project area. If the lizard surveys identify populations of threatened lizard the associated habitats will be significant under Policy 13-5 (a) (ii) (A).

- Vegetation clearance or earthworks within or within a 10-metre setback from a natural wetland is restricted under the National Environmental Standards for Fresh

Water (NES-FW). Wetland delineation is required to determine whether the wetlands are natural.

- The Ōhau River is significant habitat for indigenous fish and water intake and outlet channels, as well as intake structures, should be designed to be unattractive to fish and to prevent fish entrainment.

10. CONCLUSIONS

The site proposed for the Poads Road Water Storage Reservoir at Poads Road, Levin comprises four terrestrial habitats, of which grazed exotic grassland is the most extensive. There are around four small areas of potential wetland habitat in the project area. Wetland delineation is required to determine whether these are 'natural wetland' habitats as defined in the National Policy Statement for Freshwater Management. If these are classified as a 'natural wetland,' the NES-FW restricts vegetation clearance on their margins and the discharge of water into natural wetlands, which may constrain development.

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Areas of formed rock piles within the exotic grassland may potentially provide habitat for terrestrial lizard species, which are protected under the Wildlife Act (1953). A lizard survey is required to determine whether indigenous lird populations are present within the project area. Any threatened lizards be significant under Policy 13-5 in the Horizons One Plan. If lizards are present within the area to be affected, a Lizard Management Plan will be required.

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APPENDIX 1

VASCULAR PLANT SPECIES RECORDED IN THE PROJECT AREA, JANUARY 2022

INDIGENOUS SPECIES

Dicot. trees and shrubs

Aristotelia serrata	makomako, wineberry
Brachyglottis repanda	rangiora
Carpodetus serratus	putaputawētā
Coprosma areolata	
Coprosma grandifolia	kanono, raurēkau, raurākau, manono
Coprosma propinqua var. *propinqua*	mingimingi
Coprosma robusta	karamū, kāramuramu
Coriaria arborea var. *arborea*	tutu
Fuchsia excorticata	kōtukutuku, kōnini
Geniostoma ligustrifolium var. *ligustrifolium*	hangehange
Hedycarya arborea	porokaiwhiri; pigeonwood
Leptospermum scoparium agg.	mānuka
Melicytus ramiflorus subsp. *ramiflorus*	māhoe
Ozothamnus leptophyllus	tauhinu
Pennantia corymbosa	kaikōmako
Pittosporum eugenioides	tarata; lemonwood
Plagianthus regius subsp. *regius*	ribbonwood, mānatu
Pseudopanax arboreus	whauwhaupaku, puahou, five finger
Schefflera digitata	patē
Weinmannia racemosa	kāmahi

Monocot. lianes

Ripogonum scandens	supplejack, kareao

Dicot. lianes

Metrosideros diffusa	rātā
Metrosideros fulgens	rātā
Muehlenbeckia australis	puka
Muehlenbeckia complexa	pōhuehue
Rubus cissoides agg.	tātarāmoa, tātaraheke, bush lawyer

Ferns

Adiantum cunninghamii	huruhuru tapairu, maidenhair fern
Asplenium bulbiferum	mouku, hen and chicken fern

Asplenium flaccidum	makawe, ngā makawe o Raukatauri
Asplenium polyodon	petako
Blechnum chambersii	rereti, nini
Blechnum fluviatile	kiwikiwi, kiwakiwa
Blechnum minus	swamp kiokio
Blechnum novae-zelandiae	kiokio
Cyathea dealbata	ponga, silver fern
Cyathea medullaris	mamaku
Dicksonia squarrosa	whekī
Lastreopsis glabella	
Microsorum pustulatum	kōwaowao, pāraharaha, hound's tongue fern
Microsorum scandens	mokimoki
Paesia scaberula	mātātā
Pneumatopteris pennigera	pākau
Polystichum neozelandicum subsp. *neozelandicum*	pikopiko, shield fern
Pteridium esculentum	rārahu, bracken
Pyrrosia elaeagnifolia	leather-leaf fern

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Orchids

Microtis unifolia agg.

Grasses

Austroderia toetoe	toetoe

Sedges

Isolepis prolifera

Rushes

Juncus edgariae	wi, wīwī

Monocot. herbs (other than orchids, grasses, sedges, and rushes)

Astelia hastata	kahakaha

NATURALISED AND EXOTIC SPECIES

Gymnosperms

Cupressus macrocarpa	macrocarpa
Pinus radiata	radiata pine

Dicot. trees and shrubs

Berberis glaucocarpa	barberry

Cotoneaster glaucophyllus	cotoneaster
Lupinus arboreus	lupin
Populus alba	white poplar
Prunus sp.	ornamental cherry
Rubus sp. (*R. fruticosus* agg.)	blackberry
Salix ×fragilis	crack willow
Ulex europaeus	gorse

Grasses

Agrostis capillaris	browntop
Agrostis stolonifera	creeping bent
Anthoxanthum odoratum	sweet vernal
Cynosurus cristatus	crested dogstail
Glyceria declinata	blue sweetgrass
Holcus lanatus	Yorkshire fog
Lolium perenne	rye grass
Paspalum distichum	Mercer grass

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Sedges

Carex scoparia	broom sedge

Rushes

Juncus articulatus	jointed rush
Juncus effusus var. *effusus*	soft rush, leafless rush

Composite herbs

Achillea millefolium	yarrow
Cirsium arvense	Californian thistle
Jacobaea vulgaris	ragwort
Leontodon taraxacoides	hawkbit
Mycelis muralis	wall lettuce

Dicot. herbs (other than composites)

Anagallis arvensis	scarlet pimpernel
Apium nodiflorum	water celery
Conium maculatum	hemlock
Digitalis purpurea	foxglove
Lotus pedunculatus	lotus
Lotus suaveolens	hairy birdsfoot trefoil
Lythrum hyssopifolia	hyssop loosestrife
Lythrum portula	water purslane
Mimulus guttatus	monkey musk
Myosotis arvensis	field forget-me-not
Myosotis laxa subsp. *caespitosa*	water forget-me-not
Nasturtium officinale	watercress

Parentucellia viscosa	tarweed
Persicaria hydropiper	water pepper
Phytolacca octandra	inkweed
Plantago lanceolata	narrow-leaved plantain
Plantago major	broad-leaved plantain
Ranunculus repens	creeping buttercup
Rumex acetosella	sheep's sorrel
Rumex obtusifolius	broad-leaved dock
Stellaria media	chickweed
Trifolium pratense	red clover
Trifolium repens	white clover
Vicia sativa	vetch

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Wetland Delineation at Poads Road, Levin

Contract Report No. 6201c-2

Providing outstanding ecological services to sustain and improve our environments

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Wetland Delineation at Poads Road, Levin

Contract Report No. 6201c-2

June 2024

Project Team:

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Prepared for:

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Reviewed and approved for release by:



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26/07/2024
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1.0 Introduction

Horowhenua District Council has identified the need to augment their current water supply and storage facilities for the Levin Water Treatment Plant. Good Earth Matters Consulting Ltd is preparing a resource consent application, on behalf of the District Council, to construct a new water reservoir and increase the currently consented water take from the Ohau River.

The project will involve the construction of a new water reservoir on Lot 9 DP555714 on a river terrace between Poads Road and the Ohau River, approximately six kilometres southeast of Levin (Figure 1). Water is to be provided to the reservoir from the Ohau River via a new intake structure. An outlet structure is also to be installed downstream. The currently consented rate of water extraction from Ohau River is 15,000 cubic metres (m^3/day). Damwatch (2020) indicates that additional water will need to be taken from the Ohau River to future-proof the water supply and to provide an acceptable filling rate for any proposed larger water storage reservoir to meet the demand of the expected population growth in Levin.

An initial site visit to identify ecological constraints within the proposed Poads Road Water Storage Reservoir was carried out in January 2022. The ecological constraints survey identified potential wetlands within the site, two of which were within the proposed reservoir footprint (Figure 1).

On behalf of Horowhenua District Council, Good Earth Matters Consulting Ltd asked Wildlands to undertake a wetland assessment and delineation of the areas identified in the previous constraints assessment.

2.0 Methods

The property was visited and surveyed on 2 November 2023, during which time the potential wetland habitats noted in the Wildlands constraints assessment, were described, assessed, and delineated as per the NPS-FM (see below).

The RMA defines a wetland as "*permanently or intermittently wet areas, shallow water, and land/water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions, including within the coastal marine area*".

The National Policy Statement for Freshwater Management (NPS-FM) defines a 'natural inland wetland' as:

Natural inland wetland *- a wetland (as defined in the Act) that is not:*

(a) in the coastal marine area; or

(b) a deliberately constructed wetland, other than a wetland constructed to offset impacts on, or to restore, an existing of former natural inland wetland; or

(c) a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body; or

(d) *a geothermal wetland; or*

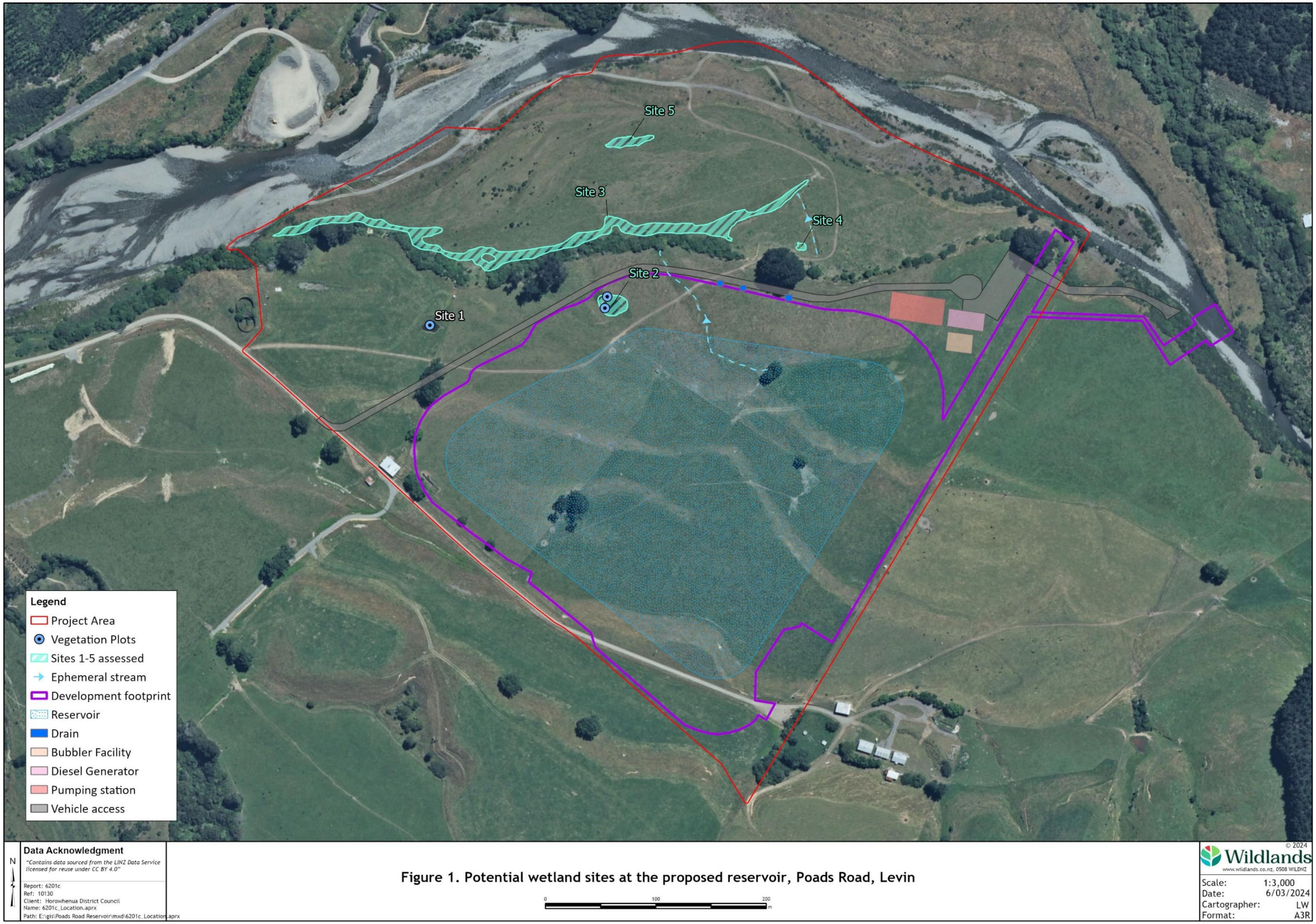


Figure 1. Potential wetland sites at the proposed reservoir, Poads Road, Levin

(e) a wetland that:

i. is within an area of pasture for grazing; and

ii. has vegetation cover comprising more than 50% exotic pasture species (as identified in the National List of Exotic Pasture Species using the Pasture Exclusion Assessment Methodology); unless

iii. the wetland is a location of a habitat of a threatened species identified under clause 3.8 of this National Policy Statement, in which case the exclusion in (e) does not apply.

According to this definition, the prerequisite for an area to be classed as a 'natural inland wetland' is for the area to meet the wetland definition under the RMA and not meet any of the five exclusions provided in the NPS-FM. This definition requires that both suitable hydrological conditions and that plants that are adapted to wet conditions are dominant in the area relative to exotic pasture species.

The New Zealand vegetation tool for wetland delineation (Clarkson 2013) has become the standard methodology to assess the presence of plants adapted to wet conditions. This methodology classifies all plant species that have been recorded in wetlands into five categories:

- OBL: Obligate. Is almost always a hydrophyte, rarely in uplands (estimated probability >99% occurrence in wetlands).
- FACW: Facultative Wetland. Usually is a hydrophyte but occasionally found in uplands (estimated probability 67–99% occurrence in wetlands).
- FAC: Facultative. Commonly occurs as either a hydrophyte or non-hydrophyte (estimated probability 34–66% occurrence in wetlands).
- FACU: Facultative Upland. Occasionally is a hydrophyte but usually occurs in uplands (estimated probability 1–33% occurrence in wetlands).
- UPL: Obligate Upland. Rarely is a hydrophyte, almost always in uplands (estimated probability <1% occurrence in wetlands).

Species that are classed as OBL, FACW, or FAC are considered hydrophytic and generally indicative of wetland habitat. The relative dominance of each species, and corresponding classification, can therefore determine whether an area should be defined as wetland. In addition, Fraser *et al.* (2018) provides the methodology for assessing wetland soils, and the criteria for identifying suitable wetland hydrology are outlined in the Ministry for the Environment wetland hydrology tool (2021). Areas with a dominance of hydrophytic vegetation, hydric soil characteristics, and the appropriate hydrological conditions can therefore be defined as a 'natural inland wetland'.

3.0 Wetland delineation

3.1 Overview

Of the sites previously identified as potential wetland habitats, two are on the upper terrace, where infrastructure is to be located, and only one was demarcated within the potential footprint of the proposed reservoir. The two sites on the upper terrace are located within a large area of paddock on the upper terrace above the Ohau River. These two sites are labelled as Site 1 and Site 2 in Figure 1. The remainder of the sites (3-5) are on the lower terrace (Figure 1).

Evaluations of each of these five sites are set out below.

3.2 Site evaluations

3.2.1 Site 1

Site 1 (Plate 1) is a small depression on the upper terrace that is dominated by Yorkshire fog with frequent creeping buttercup, Sweet vernal, and browntop with occasional white clover and soft rush. No hydrologic indicators were noted, and the soil profile was dry and very friable. The matrix colour was of a high chroma and is consistent with hydric soils.



Plate 1 — Site 1 is a small depression that has more than 50 percent cover of pasture species and meets the pasture exclusion test. No hydrologic indcators were present. 22 October 2023.

Site 1 is not considered to be a natural inland wetland as it meets the pasture exclusion criteria.

3.2.2 Site 2

Site 2 is a small open-water shallow depression covering an area of *c*.400 m^2, with a narrow fringe of wetland vegetation that includes jointed rush (*Juncus articulaus*, OBL), water purslane (*Ludwigia palustris*, OBL) with abundant Yorkshire fog (*Holcus lanatus*, FAC), Mercer grass (*Paspalum distichum*, FACW), creeping bent (*Agrostis stolonifera*, FACW) and occasional patches of (*Persicaria hydropiper*, FACW), creeping buttercup (*Ranunculus repens*, FAC) sweet vernal (*Anthoxanthum odoratum*, FACU), and white clover (*Trifolium repens*, FACU).



Plate 2 —Site 2 is a wet depression in a paddock on the upper terrace, with no apparent hydrologic surface connection. 22 October 2023.



Plate 3 — Site 2, spade at the edge of wetland Vegetation Plot 2, showing the shallow water depth. 22 October 2023.

Two representative 2 × 2 metre vegetation plots were assessed in the narrow strip of vegetation surrounding the small area of open water:

- The first vegetation plot (Vegetation Plot 1 – Site 2) met the Dominance Test and had a Prevalence Index score of 1.75 as the plot is dominated by OBL and FACW species (see Appendix 1). This would qualify the site as being classified as a natural inland wetland.

- The second vegetation plot (Vegetation Plot 2 – Site 2) met the Dominance Test and had a Prevalence Index score of 2.59, which indicates that it could be classified as a natural inland wetland. However, Vegetation Plot 2 also contains more than 50 percent of pasture species and meets the pasture exclusion criteria under the NPS-FM, so would not qualify as a natural inland wetland.

The hydrology noted during the site visit is inundated with saturated soil around the margins. No discernible surface connection could be detected flowing into or away from Site 2. The site is isolated and may only receive freshwater influence from precipitation, not functioning as part of the hydraulic regime of the wider terrace.

Two soil samples were taken at both vegetation data points, to a depth of 30 cm. The soil profile exhibited low chroma soil for the first 20cm with redoximorphic features with matrix colour and along the pore lining. At 20 cm, the soil has an abundance of alluvial rock and other materials and has become noticeably much drier. At depths beyond 20cm, the soil colour had a much higher chroma than the top 20cm of the profile and appeared no longer consistent with hydric soils. There seems to be a restrictive, impermeable layer of soil material that allows water to pool during wet times of the year.

Overall, the narrow band of vegetation surrounding the small area of open water habitat is a mosaic of wetland and pasture species, which means that the vegetation cover varies between less than or greater than 50 percent cover of pasture species. The ground around the open water is heavily pugged.

This site could be classified as a wetland but it is a very marginal classification.

3.2.3 Site 3

Site 3 (Plate 4) is a larger linear feature of *c.*4,000 m^2 that has formed at the toe of the slope of the upper stream terrace and is located within the floodplain of the Ohau River. Site 3 is generally inundated with variable depths, and saturated soil is common along the margins.

The cover and composition of wetland species changes often due to the size and elongated nature of the site. Locally abundant species within the inundated areas were water celery (*Helosciadium nodiflorum*, OBL), (*Isolepis prolifera*, OBL), water purslane (OBL), and starwort (*Callitriche stagnalis*, OBL). Frequently observed species along the margins included *Juncus sarophorus* (FACW), soft rush (*Juncus effusus*; FACW), creeping buttercup (FAC), Yorkshire fog (FAC), and creeping bent (FACW). Species occasionally present in patches around the edges were *Isolepis reticularis* (FACW), and water pepper (*Persicaria hydropiper*, FACW).



Plate 4 — Site 3 is dominated by water celery, water purslane, and starwort, with soft rush and *Juncus sarophorus* along the edge. 22 October 2023.

Site 3 is considered to be an inland natural wetland based on the NPS-FM.

3.2.4 Site 4

Site 4 (Plate 5) is a small wet area of *c*.50 m^2 that has formed in a shallow depression located along a farm track with a paddock on the lower steam terrace of the Ohau River. Site 4 has small patches of bare ground, and soils are hydric with low chroma matrix displaying redox. Soil saturation was observed below 20 cm of depth in the profile. The small site contained creeping buttercup (FAC), water purslane (OBL), and jointed rush (OBL).

Site 4 is considered to be a natural inland wetland.

3.2.5 Site 5

Site 5 (Plate 6) covers *c*.276 m^2 that has formed in a shallow depression located on the floodplain of the Ohau River. It is inundated, with areas of saturated soils around the margins. The site is dominated by water purslane (OBL), *Helosciadium nodiflorum* (OBL), *Isolepis prolifera* (OBL), and starwort (*Callitriche stagnalis*, OBL) with frequent Mercer grass (FACW), soft rush (FACW), and *Juncus sarophorus* (FACW).

Site 5 is considered to be a natural inland wetland.



Plate 5— Site 4 is a small depression dominated by water pepper, water purslane, and creeping buttercup. 22 October 2023.



Plate 6 — Site 5 is a narrow wetland mostly inundated and dominated by water purslane, *Isolepis prolifera*, and Mercer grass. 22 October 2023.

4.0 Horizons One Plan

Schedule RP-SCHED6 of the Horizons One Plan recognises various wetland types that are classified as 'Threatened' or 'Rare'. Two categories of wetland at the Poads Road site are relevant: 'ephemeral' wetlands and 'seepage and spring wetlands', both of which are classified as 'Rare'.

Site 1

This is not a wetland so wetland provisions in the One plan do not apply.

Site 2

'Rare' wetlands have a minimum size threshold in RP-SCHED6 of 0.05 hectares, i.e. 500 m^2. Site 2 on the upper terrace has no discernible surface water inputs other than precipitation and is likely to dry out, and can be classified as an ephemeral wetland, although highly degraded with pasture species prominent.

However, it does not meet the minimum size threshold of 500 m^2 so is not significant in terms of the One Plan. It should be noted that although, technically, this site could qualify as a wetland, albeit

marginally, in terms of the NPS-FM, it is highly modified, the vegetation is predominantly exotic, and it is not ecologically significant. It also has little potential for ecological restoration.

Site 3

This is a seepage wetland that meets the size threshold in RP-SCHED6 of the One Plan, which means that it is classified as 'Rare'. Because of its size (*c.*4,000 m^2) and location it has potential for ecological restoration.

Site 4

This site is probably ephemeral and is very small (*c.*50 m^2) and does not meet the size threshold in RP-SCHED6 of the one Plan. In isolation, it has little potential for ecological restoration.

Site 5

This is another small (*c.*276 m^2) highly-modified wetland that doesn't meet the size threshold in RP-SCHED6 of the Horizons One Plan.

5.0 Management of potential effects

The NPS-FM provides an effects management hierarchy, in relation to natural inland wetlands and rivers, which comprises an approach to managing the adverse effects of an activity on the extent or values of a wetland or river (including cumulative effects and loss of potential value) that requires that: (a) adverse effects are avoided where practicable; then (b) where adverse effects cannot be avoided, they are minimised where practicable; then (c) where adverse effects cannot be minimised, they are remedied where practicable; then (d) where more than minor residual adverse effects cannot be avoided, minimised, or remedied, aquatic offsetting is provided where possible; then (e) if aquatic offsetting of more than minor residual adverse effects is not possible, aquatic compensation is provided; then (f) if aquatic compensation is not appropriate, the activity itself is avoided.

Site 2 will potentially fall under the footprint of the proposed reservoir so will be lost. Due to its small and degraded nature, this loss can be offset by the restoration of the degraded wetlands on the lower terrace.

Sites 3-5 are on the lower terrace and will not be directly affected. There is potential, although unlikely, for indirect effects due to sediment inputs during construction activity on the upper terrace and possibly due to changes in surface and subsurface flows.

The potential for adverse effects can be avoided by implementing the following:

- Appropriate controls on sediment management during the construction phase.
- Maintaining the opportunity for surface flows from the upper terrace to travel to the lower terrace.

Ecological restoration of the lower terrace would easily outweigh the adverse effects of very minor 'losses' on the upper terrace. An Ecological Restoration Plan could be prepared to guide this and could address the following:

- Definition of the area subject to the plan.
- Stock exclusion.
- Wetland planting.
- Wetland riparian planting.

- Terrestrial planting.
- River riparian planting (subject to the extent of the area to be restored).
- Monitoring and maintenance of plantings.
- Pest animal monitoring and control.
- Restoration/planting targets.
- Reporting.

6.0 Discussion and Summary

The property proposed for the Reservoir at Poads Road, Levin, contains five sites that were identified as potential wetlands along the lower floodplain and upper stream terrace of the Ohau River, and all of these sites have now been subject to a further wetland delineation assessment.

Site 2, on the upper terrace, is a 'marginal' very small and highly degraded wetland which could potentially be impacted by the proposed reservoir works. This site is a shallow, isolated feature that comprises a mosaic of wetland and pasture species. Site 2 did not have an apparent hydrologic surface connection and is most likely seasonal (i.e. ephemeral; drying out over summer) with little influence on the hydrologic regime. As such, it is of very limited ecological value.

It is not anticipated that Sites 3-5 on the lower terrace will be directly affected by construction of the proposed reservoir and associated infrastructure. Sites 1, 2, 4, and 5 do not meet the size threshold in the Horizons One Plan.

Construction of the reservoir may be a discretionary activity in terms of National Environmental Standards for Freshwater: construction of specified infrastructure – Urban development (45C Discretionary activities).

Restoration of the wetland areas on the lower floodplain of the Ohau River would easily mitigate the loss of Site 2, and this approach would very substantially outweigh the minor adverse effects associated with the loss or modification of this small, highly modified 'marginal' wetland.

An Ecological Management Plan should be provided for restoration of the lower stream terrace.

Acknowledgments

Annette Sweeney from Good Earth Matters Consulting Ltd is thanked for providing site access and project liaison, and Neil Carr is thanked for providing updated site plans and background information.

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Appendix 1

Vegetation plot information

Site 1 Vegetation Plot 1

Vegetation Plot Data						
Stratum	**Species Name**	**Common Name**	**% Cover**	**Dominant?**	**Indicator Status**	**Pasture Species?**
Herb 2 x 2 m	*Holcus lanatus*	Yorkshire fog	60	YES	FAC	Y
	Ranuculus repens	Tāwheowheo	15	NO	UPL	N
	Anthoxanthum odoratum	Sweet vernal	10	NO	FACU	Y
	Agrostis capillaris	Browntop	8	NO	FACU	Y
	Trifolium repens	White clover	5	NO	FACU	Y
	Juncus effusus	Soft rush	5	NO	FACW	N
	Juncus sarophorus		3	NO	FACW	N
		Total Cover:	106			
		20% Cover:	21			
		50% Cover:	53			

Dominance Test	
Number of dominant species OBL, FACW, or FAC (A) =	1
Total number of dominant species across all strata (B) =	1
Percent of dominant species that are OBL, FACW, or FAC (A/B) =	100%
Wetland vegetation determination =	**WETLAND**

Prevalence Index			
Indicator Status	**Total % Cover**	**Multiplication Factor**	**Mulitplied % Cover**
OBL	0	x 1 =	0
FACW	8	x 2 =	16
FAC	60	x 3 =	180
FACU	23	x 4 =	92
UPL	15	x 5 =	75
Total (A)	106	Total (B)	363
		Prevalence Index (B/A) =	3.42
		Wetland vegetation determination =	**NOT WETLAND**

Pasture Exclusion Test	
Pasture Species Cover =	83
Total Vegetation Cover =	106
% Cover of Pasture Species =	78%
Pasture determination =	**PASTURE**

Soil Analysis						
Depth	**Matrix Colour**	**Mottles Colour**	**Mottles %**	**Mottle Location**	**Material**	**Comments**
0-20	10YR 4/4	7.5YR 5/6	2%	Pore lining & matrix	Mineral soil	friable/ very dry
			Location	Flat		
			Water table depth (cm)	0		
			High groundwater	0		
			Pan	0		

Soil Analysis						
Depth	**Matrix Colour**	**Mottles Colour**	**Mottles %**	**Mottle Location**	**Material**	**Comments**
			Pan depth (cm)	0		
			Pugged	0		
			Wetland soil determination =	**NOT WETLAND**		

Wetland hydrology	
Total No. Primary Indicators =	0
Total No. Secondary Indicators =	0
Wetland hydrology determination =	**NOT WETLAND**

Site 2 Vegetation Plot 1

Vegetation Plot Data						
Stratum	**Species Name**	**Common Name**	**% Cover**	**Dominant?**	**Indicator Status**	**Pasture Species?**
Herb 2 x 2 m	*Juncus acuminatus*	Sharp-fruited rush	40	YES	OBL	N
	Ludwigia palustris	Water purslane	12	NO	OBL	N
	Paspalum distichum	Mercer grass	10	NO	FACW	N
	Holcus lanatus	Yorkshire fog	10	NO	FAC	Y
	Ranunculus repens	Creeping buttercup	10	NO	FAC	N
	Anthoxanthum odoratum	Sweet vernal	5	NO	FACU	Y
		Total Cover:	87			
		20% Cover:	17			
		50% Cover:	44			

Dominance Test	
Number of dominant species OBL, FACW, or FAC (A) =	1
Total number of dominant species across all strata (B) =	1
Percent of dominant species that are OBL, FACW, or FAC (A/B) =	100%
Wetland vegetation determination =	**WETLAND**

Prevalence Index			
Indicator Status	**Total % Cover**	**Multiplication Factor**	**Multiplied % Cover**
OBL	52	x 1 =	52
FACW	10	x 2 =	20
FAC	20	x 3 =	60
FACU	5	x 4 =	20
UPL	0	x 5 =	0
Total (A)	87	Total (B)	152
		Prevalence Index (B/A) =	1.75
		Wetland vegetation determination =	**WETLAND**

Pasture Exclusion Test	
Pasture Species Cover =	15
Total Vegetation Cover =	87
% Cover of Pasture Species =	17%
Pasture determination =	**NOT PASTURE**

Soil Analysis						
Depth	**Matrix Colour**	**Mottles Colour**	**Mottles %**	**Mottle Location**	**Material**	**Comments**
0-10	10YR 3/1	10YR 5/6	2%	Pore lining	Mineral soil	0
10-20	10YR 4/2	7.5YR 4/4	15%	Matrix	Mineral soil	very rocky under 20cm
20-30	10RY 5/4	7.5RY 4/6	20%	Matrix	Mineral soil	Not hydric, High chroma matrix colour

Location	Flat
Water table depth (cm)	0
High groundwater	0
Pan	YES
Pan depth (cm)	20cm
Pugged	YES
Wetland soil determination =	Wetland soil present between 0-20cm. After 20cm soil become dry with high chroma matrix.

Wetland hydrology	
Surface water (1A)	Primary Indicator
Soil saturation <30 cm (1C)	Primary Indicator
Total No. Primary Indicators =	2
Total No. Secondary Indicators =	1
Wetland hydrology determination =	**WETLAND**

Site 2 Vegetation Plot 2

Vegetation Plot Data						
Stratum	**Species Name**	**Common Name**	**% Cover**	**Dominant?**	**Indicator Status**	**Pasture Species?**
Herb 2 x 2 m	*Holcus lanatus*	Yorkshire fog	40	YES	FAC	Y
	Juncus acuminatus	Sharp-fruited rush	20	NO	OBL	N
	Paspalum distichum	Mercer grass	20	NO	FACW	N
	Trifolium repens	White clover	7	NO	FACU	Y
	Agrostis capillaris	Browntop	5	NO	FACU	Y
	Anthoxanthum odoratum	Sweet vernal	5	NO	FACU	Y
	Agrostis stolonifera	Creeping bent	5	NO	FACW	N
	Ludwigia palustris	Water purslane	3	NO	OBL	N
		Total Cover:	105			
		20% Cover:	21			
		50% Cover:	53			

Dominance Test	
Number of dominant species OBL, FACW, or FAC (A) =	1
Total number of dominant species across all strata (B) =	1
Percent of dominant species that are OBL, FACW, or FAC (A/B) =	100%
Wetland vegetation determination =	**WETLAND**

Prevalence Index			
Indicator Status	**Total % Cover**	**Multiplication Factor**	**Mulitplied % Cover**
OBL	23	x 1 =	23
FACW	25	x 2 =	50
FAC	40	x 3 =	120
FACU	17	x 4 =	68
UPL	0	x 5 =	0
Total (A)	105	Total (B)	261
		Prevalence Index (B/A) =	2.49
		Wetland vegetation determination =	**WETLAND**

Pasture Exclusion Test	
Pasture Species Cover =	57
Total Vegetation Cover =	105
% Cover of Pasture Species =	54%
Pasture determination =	**PASTURE**

Soil Analysis						
Depth	**Matrix Colour**	**Mottles Colour**	**Mottles %**	**Mottle Location**	**Material**	**Comments**
0-10	10YR 3/1	10YR 5/6	2%	Pore lining	Mineral soil	0
10-20	10YR 4/2	7.5YR 4/4	10%	Matrix	Mineral soil	very rocky under 20cm
20-30	10RY 5/4	7.5RY 4/6	20%	Matrix	Mineral soil	not wet, High chroma
				Location	Flat	
				Water table depth (cm)	0	
				High groundwater	0	
				Pan	YES	
				Pan depth (cm)	20cm	
				Pugged	YES	
				Wetland soil determination =	**WETLAND**	

Wetland hydrology	
Surface water (1A)	Primary Indicator
Soil saturation <30 cm (1C)	Primary Indicator
Total No. Primary Indicators =	2
Total No. Secondary Indicators =	0
Wetland hydrology determination =	**WETLAND**

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Appendix M

PROPOSED CONSENT CONDITIONS

LEVIN WATER HARVESTING & RESILIENCE PROJECT: PROPOSED CONSENT CONDITIONS

Strategy

Management Strategy: Sets overarching objectives for the Levin Water Supply Scheme with a focus on reducing losses, managing demand and ensuring growth does not increase effects on awa, in consultation with iwi/hapū. **Review and update every six years (aligned with LTP).**

Offsetting

Cultural Offsetting: Final COMP to be confirmed within first two years. Implement as per COMP to ensure no net loss, or preferably net gain, of mauri, habitat and wetland values. Implemented by qualified persons approved by iwi/hapū. **Monitoring in years 3 and 5; Review in year 8.**

Water Take

When River is Above Minimum Flow: Daily take of up to 15,409 m^3/day which can be taken as needed across three intakes:

- Existing WTP Intake: up to 15,409 m^3/day.
- Reservoir Intake: up to 7,500 m^3/day (Can be increased to 15,409 m^3/day in emergency if existing WTP intake site is inoperable).
- NZTA (SH1) intake: up to 2,400 m^3/day during Ō2NL construction period only.

Additional non-consumptive take of 750 m^3/day at existing WTP intake site as per existing consent.

Additional Supplementary Take when river is above median flow:

- Up to 10% of the river flow at the Reservoir site.

When River is Below Minimum Flow:

- Prior to Reservoir : up to 13,000 m^3/day at Existing Intake site as per existing consent. Water restrictions must be implemented.
- After Reservoir is Operational: up to 13,000 m^3/day only in exceptional circumstances (defined in conditions). Water restrictions must be implemented. Engagement with iwi/hapū and after event review required.

Flow metering and telemetry on all intake sites as per standard conditions and RMA regulations.

Operational Management & Reporting

Demand Management Plan: As per existing Management Plan until reservoir is operational. Major review and update within six months of commissioning reservoir, to align with Management Strategy objectives and provide new restriction framework that considers reservoir levels as well as river flows. Undertaken in consultation with iwi/hapū. **Review every six years thereafter.**

Water Supply & Reservoir Operational Plan to set out how the reservoir and overall water supply system will be operated and managed. Draft required prior to reservoir commissioning. Finalised after 12 months of operational experience. **Review and update every six years.** Prepared and reviewed in consultation with iwi/hapū.

Annual Reporting: Annual compliance report to be submitted to Regional Council. Network efficiency reporting to be the same as Taumata Arowai reporting to avoid duplication. Reporting for water year 1 July to 30 June, to be submitted by 30 September.

Figure 1: Summary of Conditions, excluding Construction

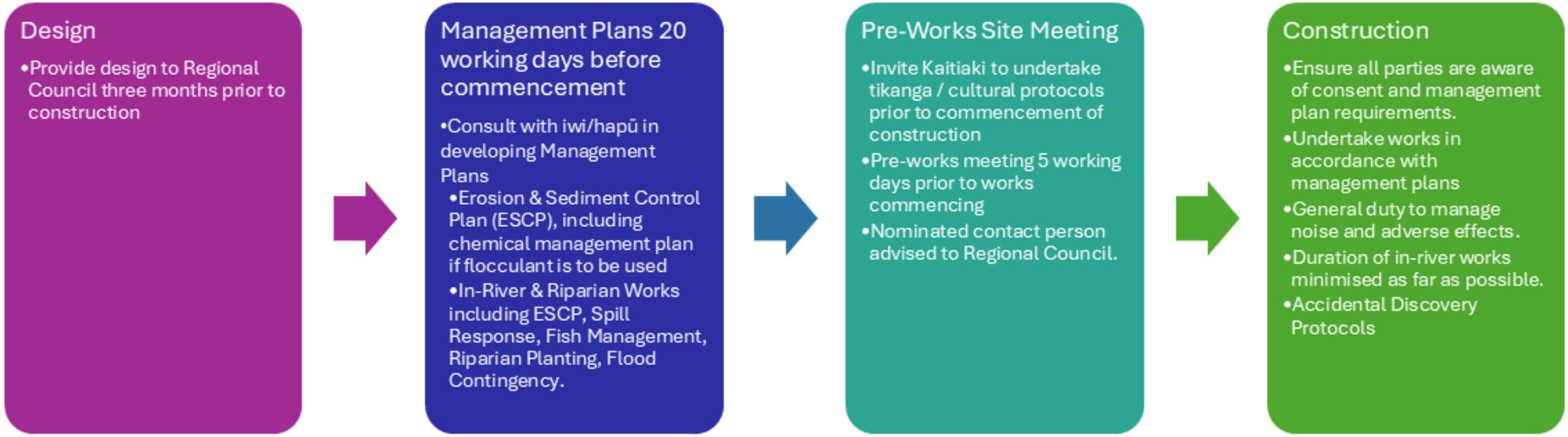


Figure 2: Summary of Construction Conditions

In addition to the above conditions, it is more than likely that the Designation for the site will require a Construction Management Plan which addresses construction effects such as noise, dust, vibration, traffic management and protocols regarding archaeological approvals and discoveries. The latter shall be developed with the advice of a suitably qualified archaeologist. Irrespective of whether or not a Construction Management Plan is required as a condition of the designation, these effects will need to be managed through appropriate contract conditions and construction methodology in order to minimise nuisance effects on adjacent landowners, users of the Te Araroa trail which passes the site, and to meet the Council's general duty under s16 and s17 of the Resource Management Act.

- S16(1) states: *"Every occupier of land (including any premises and any coastal marine area), and every person carrying out an activity in, on, or under a water body or the coastal marine area, must adopt the best practicable option to ensure that the emission of noise from that land or water does not exceed a reasonable level."*
- S17(1) states: *"Every person has a duty to avoid, remedy, or mitigate any adverse effect on the environment arising from an activity carried out by or on behalf of the person, whether or not the activity is carried on in accordance with … a resource consent, or a designation."*

Table 1: Proposed Consent Conditions

The following consent conditions are offered by the Applicant. These do not reflect the final consent conditions which will be determined via the RMA statutory consenting process.
Term of Consent sought: 35 years.

Topic	No.	Condition
Activity Authorised	1	This consent authorises: a. The abstraction of water from the Ohau River for purposes of supplying the Levin Drinking Water Supply Scheme subject to rates and volumes of abstraction as specified in conditions 11 to 17 at the following locations: i. Existing Water Treatment Plant (WTP) sub-surface intake located in the bed of the Ohau River on the properties legally described as Pt Lot 1 DP 2127 and Pt Lot 3 DP 2127 at approximate map reference NZTopo50 BN33:964-959 (The 'WTP Intake' site). ii. Reservoir Sub-surface intake located in the bed of the Ohau River on the property legally described as Lot 1 DP 12594 at approximate map reference NZTopo50 BN33:998-965 (the 'Reservoir Intake' site). In addition to the above and subject to the rates and volumes specified in this consent for the Levin Drinking Water Supply Scheme, the consent authorises a temporary abstraction from the Ohau River at or near the proposed bridge across the Ohau via a screened surface intake or shallow bore, for the purposes of supplying construction water to the Ōtaki to North Levin State Highway 1 (Ō2NL) project (The 'Ō2NL Project Intake' site). b. The construction, operation and maintenance of an off-river water supply reservoir at Lot 9 DP 555714 including: i. large scale earthworks and earthworks that affect a natural inland wetland, ii. the discharge of water from the reservoir to the Ohau River at approximately grid reference BN33:997-967, iii. the diversion of groundwater from underneath the reservoir, including the drainage of a natural inland wetland, and the discharge of the same to land and water (being a floodplain terrace and unnamed tributary of the Ohau River respectively) at approximate grid reference BN33:992-967. c. The construction, operation and maintenance of a new sub-surface river intake located in the bed of the Ohau River ('Reservoir Intake') at approximate grid reference BN33:998-965 including: i. riparian vegetation disturbance, earthworks and associated sediment discharge ii. in-stream riverbed disturbance and associated discharge of sediment to construct, operate and maintain sub-surface intake to supply water to the reservoir. d. Wetland and habitat restoration works on Lot 9 DP 555714. e. The construction, operation and maintenance of a pipeline bridge across the Ohau River in alignment with and on the upstream side of the existing Poads Road bridge at approximate grid reference BN33:984-965. f. The construction and operation of two shallow bore sub-surface water intakes at the Ō2NL Project Intake Site.
	2	The Consent Holder must undertake the activity in general accordance with the consent application including all accompanying plans and documents first lodged with Horizons Regional Council on November 2024, and the information included in the following further information responses: • To be listed as necessary Where there may be inconsistencies between the information provided by the Consent Holder and conditions of the resource consent, the conditions of the resource consent will apply.

Topic	No.	Condition
Management Strategy	3	The Consent Holder must prepare and implement a "Management Strategy for the Levin Drinking Water Scheme" (Management Strategy) which details how the Consent Holder will achieve the following Management Objectives during the term of the consent: a. The amount of treated drinking water lost to leakage from Levin Water Supply System will be reduced. b. Existing and new households will be supported to invest in and construct rainwater tanks. c. Beneficial uses for treated wastewater will be identified, investigated and where proven feasible adopted to minimise freshwater takes. d. Sustainable outcomes for resource management including minimising energy use must be achieved. e. Freshwater takes during low flow will be minimised through ongoing review and implementation of best management practice. f. The effects of the drinking water take will not grow over time in response to urban growth as a result of the Management Strategy. The consent holder must consult with iwi/hapū during the preparation of the Management Strategy. A copy of the Management Strategy must be provided to the Regional Council, iwi/hapū within three months of completion.
	4	The Consent Holder must review and update the Management Strategy prepared in accordance with condition 3 no less frequently than every six years, with the reviews to be undertaken in the same year that the Consent Holder undertakes its Long-Term Plan process. The Consent Holder must consult with, and seek feedback from iwi/hapū when undertaking the review and must address the feedback from iwi/hapū within the updated Management Strategy. A copy of the updated Management Strategy must be provided to the Regional Council and iwi/hapū within three months of the Management Strategy being updated.
Cultural Offsetting	5	Within six months of commencement of consent, the Consent Holder must invite iwi to prepare a final Cultural Offsetting Management Plan (COMP) to be prepared in general accordance with the draft COMP submitted as part of the application documents. The objective of the COMP is to demonstrate how no net loss, and preferably a net gain of mauri in the Ohau Awa and habitat availability, are achieved through the implementation of offset activities. The COMP may include: a. Identification of appropriately qualified person, approved by iwi to oversee the Cultural Offsetting and the person's roles and responsibilities. b. A summary of the cultural values at the reservoir and intake site (impacted site) and offset site, being the area identified in Figure 6 of the draft COMP. c. A monitoring framework that can measure the identified cultural values including mauri and habitat availability. d. A summary of approaches needed to enhance mauri and habitat availability at the offset site to achieve a no net loss and preferably a net gain. e. Details of the programme of actions required to achieve the offset. f. A description of the offset principles and how the offset will achieve the principles to guide the development of the cultural effects offset proposal.
	6	The Consent Holder must engage a suitably qualified ecologist to review the COMP and confirm that the implementation of the COMP will result in no net loss of wetland habitat and values arising from the construction of the reservoir and that all relevant conditions of Regulation 55 of the National Environmental Standards for Freshwater (NES-FW) are met. Should the suitably qualified ecologist identify that additional wetland enhancement and restoration is required to ensure that there is no net loss of wetland extent or values, the Consent Holder must engage the ecologist to confirm the additional enhancement and restoration required and / or amendments required to ensure compliance with Regulation 55 of the NES-FW and must integrate those additional measures into the final COMP action programme.
	7	The Consent Holder must provide the final COMP to the Regional Council for certification. If a final COMP has not been provided by iwi within eighteen months of the invite from the consent holder under condition 5, the Consent Holder must update the draft COMP included in the application documentation as the final COMP and provide this to Regional Council for Certification.

Topic	No.	Condition
	8	The Consent Holder must engage an appropriately qualified person(s) to implement the COMP in accordance with the programme of works detailed in the COMP. Any departure from the agreed actions and programme must be confirmed and agreed with iwi. The consent holder must invite iwi to nominate persons who they consider to be appropriately qualified person(s) for this purpose prior to the consent holder engaging any such person.
	9	In the third and fifth years following the completion of the cultural offsetting works, monitoring in accordance with the Cultural Offsetting Management Plan framework must be undertaken by a suitably qualified person(s). The consent holder must invite iwi to nominate persons who they consider to be appropriately qualified person(s) for this purpose prior to the consent holder engaging any such person.
	10	In the eighth year following the completion of the cultural offsetting works, the offsetting measures must be reviewed by a suitably qualified person(s) approved by iwi, to ensure no net loss has been achieved. The review must include: a. A summary of progress towards achieving no net loss and preferably net gain of mauri and an assessment of progress in achieving the restoration objectives. b. Confirmation of whether net loss or net gain of mauri have been achieved or are expected to be achieved. c. If required, recommended additional measures to be implemented to achieve no net loss or net gain of mauri. d. If no net loss has not been achieved or is not expected to be achieved, the COMP must be reviewed, and new actions included to achieve no net loss or net gain of mauri. The updated COMP must be provided to the Regional Council for certification as per condition 7. In undertaking the review, the Consent Holder must consult with iwi and seek their feedback on the above matters. A review report must be completed by the Consent Holder addressing the above matters and detailing any feedback received from iwi, as well as how the consent holder proposes to address the feedback from iwi. A copy of the review report must be provided to Regional Council within three months of its completion.
Water Take Locations; Rate and Volume of Take	*Note: Core allocation is as per existing water permit ATH-1991006011.03 which authorises the abstraction of 15,000 m³/day of water for the Levin water supply until July 2042 and existing water permit ATH-2022203743.00 which authorises up to 409 m³/day from the reservoir site. The existing water permits will be surrendered on grant of this consent.*	
	11	**Core Allocation Abstraction when River is Above Minimum Flow** The Consent Holder may abstract up to 15,409 m³/day from the Ohau River, at times when the Ohau River is above 820 L/s as measured at the Rongomatane Gauging Site. Subject to the total abstraction across all three intake sites not exceeding 15,409m³/day, the consent holder may: a. Abstract up to 15,409 m³/day from the WTP Intake site at a maximum instantaneous rate not exceeding 206 L/s. b. Abstract up to 7,500 m³/day from the Reservoir Intake site at a maximum instantaneous rate not exceeding 400 L/s except as provided for under condition 13 (Emergency Abstraction at Reservoir Intake Site). c. Prior to 31 December 2033, abstract up to 2,400 m³/day from the Ō2NL Project Intake site at a maximum instantaneous rate not exceeding 50 L/s. *Advice Note: per day refers to midnight to midnight* *Advice Note: Abstraction under c is only for construction water for the Ō2NL project. The date in c is the expected completion date plus some contingency time allowance. If Ō2NL project is completed ahead of schedule, then the abstraction would also cease at the time of completion. If the project is delayed beyond the date specified above, a variation to this consent would be required to continue to exercise the abstraction under c.*
	12	In addition to abstraction under 11a, 15 and 16, up to 750 m³/day may be taken for non-consumptive use at the WTP intake site. This water is to be returned to the Ohau River within 400 m of the point of take. *[Note: this is as per the existing consent for the Levin Water supply]*

Topic	No.	Condition
	13	**Emergency Abstraction At Reservoir Intake Site** When the Ohau River is above 820 L/s as measured at the Rongomatane Gauging Site and in the event of a failure of the WTP intake site, the Consent Holder may abstract more than 7,500 m^3/day and up to 15,409 m^3/day from the reservoir intake site at a maximum instantaneous rate not exceeding 400 L/s until such time as repairs have been given effect to and the WTP intake site is operational. When abstracting water in accordance with this condition, the Consent Holder must: a. As soon as practicable, notify Horizons Regional Council, iwi/hapū of the need to abstract water in accordance with this emergency abstraction condition. This notification must include the reasons for the emergency abstraction; plans for undertaking repair works and an estimation as to how long it will take to undertake repairs at the WTP intake site. If it is not known how the repairs will be undertaken or the likely duration of the repair work, the notification must advise when these details are expected to be known. A further update must be provided to the Regional Council, iwi/hapū when details of the repair work and duration are known. b. If the repairs will take more than 24 hours to be undertaken, the Consent Holder must implement water restrictions in accordance with the Water Demand Management Plan and must manage the abstraction and reservoir levels as far as possible to minimise the amount of abstraction that is required above 7,500 m^3/day. c. If the repairs will take more than 7-days to be undertaken, the Consent Holder must provide weekly updates on progress of repairs and estimated completion timeline. d. As soon as practicable after completion of repairs, notify Horizons Regional Council, iwi/hapū that abstraction under this condition has ceased and normal abstraction regime as per condition 11 has recommenced.
	14	**Supplementary Allocation Abstraction** When the Ohau River is above 3,810 L/s as measured at the Rongomatane Gauging Site (Median Flow), the Consent Holder may, in addition to the core allocation abstraction authorised in condition 11, abstract up to 10% of the river flow at the reservoir intake site.
	15	**Abstraction when River is Below Minimum Flow Prior to Reservoir Being Operational** Prior to the reservoir being operational, the Consent Holder may abstract water from the WTP Intake Site when the Ohau River is below 820 L/s as measured at the Rongomatane Gauging Site. Abstraction must not exceed 13,000 m^3/day at a maximum instantaneous rate not exceeding 168 L/s and an average rate of take not exceeding 150 L/s. At all times that abstraction is occurring when the river is below 820 L/s, the consent holder must implement the highest level of water restrictions detailed in the Water Demand Management Plan.
	16	**After Reservoir is operational, Exceptional Circumstances Abstraction when River is Below Minimum Flow** At times when the Ohau River is below 820 L/s as measured at the Rongomatane Gauging Site, the Consent Holder may abstract up to 13,000 m^3/day **from the WTP intake site** subject to any one of the following circumstances being met: a. The reservoir level is below 50% and the long-term weather forecast shows that minimum flow conditions are likely to continue; or b. The reservoir level is below 30%; or c. There has been a failure of pipeline conveyance between the reservoir and the WTP that is unable to be remedied within 12 hours, or the remaining supply time available in post-treatment storage whichever is the lesser.

Topic	No.	Condition
	17	At all times when the Consent Holder is abstracting at times when the Ohau River is below 820 L/s as measured at the Rongomatane Gauging Site in accordance with condition 16: a. The Consent Holder must implement the highest (most restrictive) restriction level in the Water Demand Management Plan and must maintain, and actively enforce, restrictions at that level. b. If the abstraction is initiated because of reservoir levels, the Consent Holder must notify the Regional Council, iwi/hapū prior to commencing abstraction from the river. c. If the abstraction is initiated because of a failure of the pipeline conveyance, the Consent Holder must notify the Regional Council, iwi/hapū within 24 hours of the abstraction commencing. d. For the duration of the period that abstraction is occurring under condition 16, the Consent Holder must provide weekly updates to the Regional Council and iwi/hapū. The updates are to include details of reservoir levels, effectiveness of water restrictions, actions being undertaken to give effect to any repairs (where the abstraction is in accordance with c above) and likely timeframe over which it is expected that abstraction under minimum flow conditions will continue. This update may be in the form of an email or similar format.
	18	Within two months of the minimum flow abstraction under condition 16 ceasing, a report is to be provided to the Regional Council, iwi/hapū detailing the duration of the minimum flow abstraction, reasons for it occurring and any recommendations and actions to be taken by the consent holder to avoid or minimise the need to abstract when the river is below minimum flow in the future.
		Flow metering: Standard conditions to be added which require: • *verified flow meters at all abstraction locations, including regular recertification /revalidation;* • *telemetry of data to Horizons Regional Council* • *daily totalisation of all abstractions to ensure compliance with the daily task limit of this consent.* • *Horizons standard conditions re access to meters; notification of any equipment failures / down-time.*
Reservoir Operations	19	Prior to the commissioning of the reservoir, the consent holder must prepare a draft Water Supply & Reservoir Operational Plan (WSROP) which details how the reservoir will be operated within the overall water supply system. It must include but not be limited to: a. Roles and responsibilities for managing the water supply reservoir and abstractions from the river. b. Decision making framework and standard operating procedures for determining abstractions from each of the intake sites based on river flows, demand projections and reservoir levels. c. Measures to manage the water quality within the water supply reservoir to ensure that it remains of acceptable quality for source water for the water treatment plant. d. Methods of measuring flow in the Ohau River at the reservoir intake site and control system to ensure that the amount of water taken when the river is above median flow does not exceed 10% of the river flow at that location. e. Monitoring, operations and maintenance procedures for the reservoir and intake site including all ancillary equipment and processes at the site. The Consent Holder must consult with iwi/hapū and seek their input into the draft WSROP A copy of the draft WSROP must be provided to the Regional Council prior to commissioning of the reservoir.

Topic	No.	Condition
	20	The Consent Holder must review and update the draft Water Supply & Reservoir Operational Plan prepared under condition 19 after a minimum of 12 months and maximum of 18 months of operational experience (i.e. 12-18 months after commissioning). The review must consider how the reservoir has operated since commissioning, including over the summer-autumn period (being the period when minimum flow conditions are most likely to be experienced) and identify any changes to the WSROP required to manage water quality within the reservoir, and to manage the reservoir levels to avoid or minimise the need to abstract from the river under condition 16 (minimum flow abstraction). The Consent Holder must consult with iwi/hapū and seek their input into the review and update of the WSROP. A copy of the updated WSROP must be provided to the Regional Council, iwi/hapū within three months of it being updated.
	21	The Consent Holder must operate the reservoir intake site and reservoir in accordance with the WSROP.
	22	The Consent Holder must review the WSROP every six years. The Consent Holder must consult with iwi/hapū and seek their input into the review and update of the WSROP. A copy of the updated WSROP must be provided to the Regional Council, iwi/hapū within three months of it being updated.
Demand Management & Network Efficiency	23	Prior to the reservoir being commissioned and the Water Demand Management Plan being updated in accordance with condition 24, the Consent Holder must operate the water supply scheme in accordance with the Water Demand Management Plan for the Levin Water Supply dated July 2022, or any subsequent updates.
	24	No later than six months after commissioning of the reservoir, and then no less frequently than every six years thereafter, the Consent Holder must review and update the Water Demand Management Plan to ensure that it gives effect to the objectives for the Levin Water Supply Scheme as detailed in the Management Strategy required under condition 3 and to include as a minimum: a. Measures to ensure, on an ongoing basis, that the water supply network is managed in accordance with best practice measures with respect to leakage and demand management including target performance standards and monitoring and reporting to be undertaken to track progress towards those performance standards. b. Measures to encourage the community to respect the importance of the water resource and to reduce use and achieve efficient use on an ongoing basis in addition to dry or water short periods. c. Measures to encourage use of rainwater for non-potable use at a property level and to encourage water sensitive urban design. d. A refreshed and updated water conservation / restriction framework to be implemented during dry periods including trigger levels based on a combination of reservoir levels, river flows and long-term weather forecasting. e. Measures to use data collected from the universal metering programme to encourage water conservation and address leakage within the council networks and connected private infrastructure (property connections). f. Alignment of measures in the Water Demand Management Plan with the Management Strategy and with Council policies and bylaws including identifying any amendments required to those instruments to ensure the effectiveness of the WDMP and timeframe for those amendments. g. Performance indicators and measures to monitor the effectiveness of the Water Demand Management Plan. h. The Council Officer responsible for implementation and management of the Water Demand Management Plan, and the roles and responsible for specific actions within the WDMP being undertaken. The Consent Holder must consult with iwi/hapū during the review of the WDMP. A copy of the updated WDMP must be provided to the Regional Council, iwi/hapū within three months of the review being completed.
	25	The Consent Holder must operate the water supply network in accordance with the WDMP.

Topic	No.	Condition
Annual Reporting	26	The Consent Holder must prepare, and provide to Regional Council, an annual report of compliance with the consent conditions, including: a. Details of the amount of water taken and any trends in overall water use. b. Comment on the actions taken to implement the Water Demand Management Plan and the effectiveness of those actions. c. Comment on any issues raised by iwi/hapū regarding the operation of the scheme and compliance of consent conditions and how the consent holder has addressed those matters. d. A copy of the Network Environmental Performance Measures relevant to this consent as provided to Taumata Arowai as drinking water regulator in accordance with subpart 8 of the Water Services Act including any feedback received from Taumata Arowai on the Council's performance measures. e. In addition to the above, the Consent Holder may include any monitoring results of the source water from the Ohau River, and details of any changes or amendments to the Source Water Risk Management Plan prepared in accordance with section 43 of the Water Services Act including identifying any changes to the identified risks and hazards in the source water catchment. The annual report must be provided to Regional Council, iwi/hapū no later than 30 September each year for the period of 1 July to 30 June preceding. *Advice Note: Information provided under clause e will not be used by Regional Council to assess compliance with this consent. The information is provided in order to assist the Regional Council to fulfil its obligations under s46 of the Water Services Act 201 and to inform its decision making under s104G of the RMA.*
Pre-Construction Conditions		
Design submitted to Regional Council 3 months prior to construction	27	No less than three months prior to construction commencing, the Consent Holder must submit to the consent authority - for technical certification that the proposed works are within the scope of consent authorised - copies of design reports and drawings showing: a. Intake design and riparian works including details of the infiltration gallery, bank edge earthworks and vegetation removal, final form for the bank edge works and infrastructure located within 10 m of the riverbed, and proposed riparian planting. b. Reservoir construction details including bulk earthworks, embankment design, spillway design, and under-liner groundwater drainage system. c. Pipeline bridge design including construction methodology to avoid works within the riverbed, abutment and support details, earthworks and vegetation clearance within 10 m of the river bed. If the Consent Holder undertakes a staged construction approach, the Consent Holder must submit the required information for the specific stage three months prior to the construction of that stage commencing. *Advice note: The consent authority's review of the supplied information is to confirm that it is within the scope of consent granted and to inform the certification of management plans required in accordance with conditions of this consent. It does not constitute a technical design review or approval of the design from a constructability, operational, functional or safety perspective.*
Erosion and Sediment Control Plan	28	At least twenty working days prior to the commencement of construction works, a Specific Erosion and Sediment Control Management Plan (ESCP) must be prepared in accordance with Greater Wellington Regional Council's Erosion and Sediment Control Guide for Land Disturbing Activities in the Wellington Region (February 2021) (GWRC Guidelines) and Condition 29 below and submitted to Regional Council for technical certification.
	29	The Erosion and Sediment Control Plan required by Condition 28 must be generally in accordance with the Erosion and Sediment Control Plan included in the consent documentation and must contain sufficient detail to address the following matters: a. Details of all principles, procedures and practices that will be implemented to undertake erosion and sediment control, b. Methodologies for implementation of the activities with details of all non-structural erosion and sediment controls including staging and sequencing of works,

Topic	No.	Condition
		c. Timing and duration of construction and operation of control works (in relation to the staging and sequencing of earthworks), d. Details relating to the management of exposed areas and stabilisation in accordance with GWRC Guidelines, e. Specific design of erosion and sediment control measures in accordance with GWRC Guidelines, f. Maintenance, monitoring and reporting procedures, g. Rainfall response and contingency measures including procedures to minimise adverse effects in the event of extreme rainfall events, flood events and/or the failure of any key erosion and sediment control structures, h. Procedures and timing for review and/or amendment to the ESCP, i. Identification and contact details of personnel responsible for the operation and maintenance of all key erosion and sediment control structures. j. A site contour plan of a suitable scale to identify: i. The extent of soil disturbance and vegetation removal, ii. Locations of stockpiles, iii. All key erosion and sediment control structures, iv. The boundaries and area of catchments contributing to all erosion and sediment control devices, v. The locations of all specific points of discharge to the environment. vi. Any other relevant site information. k. If winter works are proposed, specific measures to be taken to manage the earthworks during the winter works period, including: i. The scope and nature of proposed winter works ii. Structural controls proposed, or existing that will be/are installed iii. Additional non-structural controls to be implemented (eg increased on-site monitoring and staging) iv. Maintenance consideration of structural controls to ensure effective access can be achieved to undertake the maintenance and controls continue to work effectively If the ESCP includes provision for chemical flocculant treatment, the ESCP must also include a Chemical Treatment Management Plan (CTMP) which has been prepared by an appropriately qualified and experienced person. No bulk earthworks may commence until written certification is provided by Council that the CTMP meets the requirements of GWRC Guidelines, and the measures referred to in that plan have been put in place. The CTMP must include as a minimum: a. Specific design details of a chemical treatment system based on a rainfall activated methodology for any impoundment devices (Sediment Retention Ponds) and any other approved impoundment devices, b. Monitoring, maintenance (including post-storm) and contingency programme (including a record sheet), c. Details of optimum dosage (including assumptions), d. Results of initial chemical treatment trial, e. A spill contingency plan, f. Details of the person or bodies that will hold responsibility for long term operation and maintenance of the chemical treatment system and the organisational structure which will support this system. If the Consent Holder undertakes a staged construction approach, the Consent Holder may submit separate ESCPs for each stage of the construction programme. The ESCP for

Topic	No.	Condition
		each stage must be submitted no later than twenty working days prior to the commencement of the relevant stage.
	30	The ESCP (and CTMP if required) must be certified in writing by the Manawatū-Whanganui Regional Council acting in a technical certification capacity prior to any activities authorised by this resource consent commencing. The Consent Holder must undertake all earthworks authorised by this consent in accordance with the certified ESCP. *ADVICE NOTE: Regarding Manawatū-Whanganui Regional Council Technical Certification – Several conditions require the technical certification of the Manawatū-Whanganui Regional Council. That technical certification (or withholding of approval) must be based on the Manawatū-Whanganui Regional Council's assessment of whether the matters being considered achieve the objective of minimising sediment discharges from the site to the extent practicable.*
	31	The ESCP may be amended or updated without the need for certification where the amendment is an administrative change, including nominating personnel.
	32	Except as provided for in Condition 31, amendments to the ESCP and any appendices must be confirmed in writing by the Consent Holder and certified in writing by the Manawatū-Whanganui Regional Council acting in a technical certification capacity prior to the commencement of any works to which the amended ESCP relate.
	33	The Consent Holder must ensure that a copy of the certified ESCP, including any certified amendments, is kept on site and this copy is updated within five (5) working days of any amendments being certified.
	34	The Consent Holder must ensure that all sediment laden runoff from the site is treated by sediment retention structures. These structures must be fully operational before bulk earthworks commence and must be maintained to perform at least at 80% of their operational capacity.
	35	Prior to commencement of bulk earthworks (or each stage of bulk earthworks if construction is to be staged), a certificate signed by a suitably qualified and experienced person must be submitted to the Manawatu-Whanganui Regional Council to certify that the erosion and sediment controls have been constructed in accordance with the certified ESCP required by Conditions 28 and 29. Certified controls must include Sediment Retention Ponds, Dirty Water Diversions, and Clean Water Diversions. The certification for these subsequent measures must be supplied within 5 working days upon completion of construction of those measures. Information supplied if applicable must include: a. Confirmation of contributing catchment area, b. The location, capacity and design of each structure, including shape, volume and design of the structure (dimensions of structure), c. Position of inlets/outlets, d. Stabilisation of the structure, e. Measures to control erosion, f. Any other relevant matter. *Advice Note: The format for certification is available on the Manawatu-Whanganui Regional Council website.*
In-River and Riparian Works Integrated Construction Management Plan	36	At least 20 working days prior to commencing works to construct the reservoir intake, the Consent Holder must submit to the consent authority, for technical certification, an In-River and Riparian Works Integrated Construction Management Plan which must include, as a minimum: a. Construction Methodology including proposed details for diversion of the river during the works, resourcing and planning to minimise the construction period as far as possible. This must include an Erosion and Sediment Control Plan for the in-river and riparian works prepared in accordance with conditions 29 to 36. b. Roles and responsibilities for implementing the In-River and Riparian Works Integrated Construction Management Plan. c. Measures to prevent the introduction and spread of aquatic pests, weeds and any invasive species. d. Spill Response Plan which must include, as a minimum: i. Identification of hazardous substances and machinery to be used in the works and an assessment of the risks of spills occurring including identification of areas that could

Topic	No.	Condition
		be affected by a spill. ii. Measures to be implemented to reduce the risk of a spill occurring. iii. A response plan to be implemented in the event of a spill. iv. Requirements to notify the Regional Council and iwi/hapū in the event of a spill occurring. v. Persons responsible for implementing the Spill Response Plan. e. Fish Management Plan for the reservoir intake works, prepared by a suitably qualified person, which must include as a minimum: i. Methodology for undertaking fish capture and relocation from the main riverbed prior to the in-river construction works commencing. ii. How fish passage will be maintained through or around the construction area during the construction works. iii. Methodology for undertaking fish capture and relocation from the diversion channel back into the main riverbed on completion of the construction works. iv. Persons responsible for implementation of the fish capture and relocation process including kaitiaki representatives involved in, and providing oversight of, the Fish Management Plan. f. Riparian Planting Plan, prepared by a suitably qualified person, which must include, as a minimum: i. Identification of the extent and values of the riparian vegetation to be removed to complete the intake works. ii. A planting plan detailing the area to be replanted with indigenous riparian vegetation, including details of consultation undertaken with iwi/hapū to develop the riparian planting plan and identified appropriate species. iii. Maintenance plan for maintaining the riparian planting during the establishment phase. g. Flood Contingency Plan, which must include, as a minimum: i. Identification of all equipment, machinery and materials which are required to be stored or located within the riverbed during the construction. ii. Measures to monitor the short-term and long-term weather forecast during the construction period, including communication protocols with Horizons Regional Council's Rivers Team to ensure early warning of potential flood situations. iii. Measures to remove or secure equipment, machinery and materials from the riverbed area in the event of a possible flood event. The Consent Holder must consult with iwi/hapū during the preparation of the In-River and Riparian Works Integrated Construction Management Plan and must include in the Plan details of feedback received from iwi/hapū and how that feedback has been incorporated into the Management Plan. If the feedback is not able to be incorporated, the Plan must detail the reasons for this. The Consent Holder may submit these as individual plans. If individual plans are submitted, the Consent Holder must also submit an overarching Construction Management Plan confirming roles and responsibilities for the individual plans and confirming that the individual plans are able to be implemented during the construction works and that there are no conflicting measures across the individual plans. *Advice Note: The In-River and Riparian Works Integrated Construction Management Plan is required in relation to the reservoir intake and pipeline bridge works. The consent holder may submit separate In-River and Riparian Works Integrated Construction Management Plan for each of the reservoir intake and pipeline bridge works.*
Construction *Advice Note: If the Consent Holder undertakes the construction in a staged manner, the construction conditions are to be interpreted as applying to each and every stage.*		
Nominated Contact Person	37	At least 10 working days prior to the commencement of construction the Consent Holder must appoint a representative(s) who must be the Manawatū-Whanganui Council's principal contact person(s) regarding matters relating to this resource consent. The Consent Holder must inform the Manawatū-Whanganui Regional Council of the representative's name and how they can be contacted. Should that person(s) change during the term of this resource consent, the Consent Holder must, as soon as practicable, inform the Manawatū-Whanganui Regional Council and must also give written notice to the Manawatū-Whanganui Region Council of the new representatives' name and how they

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		can be contacted.
Pre-Works Meeting	38	The Consent Holder must arrange and conduct a pre-construction site meeting and invite, with a minimum of 5 working days' notice, the Manawatu-Whanganui Regional Council, the site representative(s) nominated under Condition 37 of this consent, the contractor, and any other relevant party representing the Consent Holder prior to any work authorised by this consent commencing on site. The following information must be made available at the pre-start meeting: a. Timeframes for key stages of the works authorised under this consent. b. Resource consent conditions. c. Finalised Construction Management Plans required under this consent as relevant to the stage of works. If the works are to be undertaken in stages, with more than 2 months between successive stages, the Consent Holder must arrange and conduct a pre-construction site meeting as per this consent condition for each stage of construction. *Advice Note: In the case that any of the invited parties, other than the site representative does not attend this meeting, the Consent Holder will have complied with this condition, provided the invitation requirement is met.*
Kaitiaki	39	Prior to construction commencing, the Consent Holder shall invite iwi/hapū to undertake tikanga and cultural protocols at the site.
Communicate all consent requirements to contractors	40	The Consent Holder must be responsible for all contracted operations related to the exercise of these resource consents; and must ensure contractors are made aware of the conditions of these resource consents and ensure compliance with those conditions.
Copy of consent to be held on site during construction	41	A copy of these consent conditions must be kept onsite at all times that physical works authorised by these resource consents are being undertaken and must be produced without unreasonable delay upon request from a servant or agent of the Manawatū-Whanganui Regional Council. *ADVICE NOTE: An electronic version on a smartphone or electronic device is acceptable.*
Operate in Accordance with Management Plans	42	The Consent Holder must always operate the site in compliance with the certified ESCP and In-River and Riparian Works Integrated Construction Management Plan, certified through the conditions of this consent, including undertaking all monitoring and reporting specified in those Plans.
Avoidance of Spills	43	All earthmoving machinery, pumps, generators and ancillary equipment must be operated in a manner, which ensures spillages of fuel, oil and similar contaminants are prevented, particularly during refuelling and machinery servicing and maintenance. Refuelling and lubrication activities must be carried out away from any water body, ephemeral water body, or overland flow path, such that any spillage can be contained so that it does not enter surface water.
Accidental Discovery Protocols	44	*Conditions to be included as per Appendix 1 of the Archaeological Assessment report for the site (attached).*

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Ō2NL Project Intake Site – Construction of Intake	45	Prior to any construction works for the purposes of constructing the Ō2NL Project Intake during the months of July to March inclusive, a) a pre-construction survey must be undertaken to identify any nesting 'At Risk' or 'Threatened' braided river bird species as defined by the Department of Conservation New Zealand Threat Classification System. b) Where an active nesting site is identified by the pre-construction survey, a fifty (50) metre radius exclusion zone, measured from the nest, must be established within which no person or machinery may enter until the chicks have fledged or the nest has failed or otherwise been naturally abandoned. c) where no active nesting site is identified by the pre-construction survey, nest deterrents must be place within the construction area where that area interests with the habitat of 'at risk' or 'threatened' braided river bird species, for the duration of the construction period (i.e. being the period required to install the intake works). d) works authorised by this consent must commence within three (3) days of the survey required by clause (a) being undertaken. e) the results of the survey required by clause (a) must be provided to the Regional Council upon request.

Additional Conditions:
In addition to the above, standard conditions are expected to be added in relation to:

- Metering and telemetry requirements to record the amount of water taken at each intake including combined daily take.
- S128 review by the consent authority
- Expiry of consent

General Procedures Following the Discovery of Possible Archaeological Sites, Kōiwi / Human Remains or Taonga

3. Immediately following the discovery of material that could be an archaeological site, kōiwi/human remains and/or taonga, the Contractor will cease all work within a minimum of 20m of any part of the discovery and immediately advise the HDC, Iwi Representative(s) and project archaeologist of the discovery.

4. The HDC shall require the Contractor to secure the discovery area, ensuring the area (and any object(s) contained within) remains undisturbed and meets health and safety requirements.

   Note: It is an offence under S87 of the Heritage New Zealand Pouhere Taonga Act, 2014 to modify or destroy an archaeological site without an authority from HNZPT or in breach of the conditions of an approved authority, irrespective of whether the works are permitted or a consent has been issued under the Resource Management Act 1991.

5. The HDC shall ensure that a council representative or the Contractor, as appropriate, are available to meet and guide the Project Archaeologist and / or Iwi Representative(s) to the discovery area. The Contractor and HDC will assist with any reasonable requests any of these people may make.

6. If the discovery is determined to be an archaeological site, the site is to remain protected until such time that the Project Archaeologist has completed all of the archaeological investigations and documentation that are required as a condition of the issued authority.

7. The HDC shall ensure that no information is released to the media except as authorised by HDC in consultation with HNZPT, Iwi Representative(s) and, if required, Police.

8. The Contractor will not resume work in the area of the discovery until all archaeological investigations and documentation are completed.

Further Procedures in the Event that Kōiwi / Human Remains are Discovered

1. The discovery of kōiwi/human remains, whether of Māori or non-Māori origin, needs to be handled with respect and sensitivity. Decisions on the next steps should not be unduly rushed.

2. In addition the parties at (3), above, the HDCshall notify the following

parties of the discovery:

- The New Zealand Police. The New Zealand Police are involved in all cases of kōiwi/human remains discovery. Their primary role is to undertake a formal identification of the remains and to determine if they relate to a missing person or if a crime has been committed. This is also a requirement of the Coroners Act 1988.

- HNZPT Regional Archaeologist. The HNZPT Regional Archaeologist will (if necessary and where possible) visit a site following the notification of the discovery of kōiwi/human remains. HNZPT staff can assist in formal identification of the remains as human if required, and whether they are associated with an archaeological site and therefore require an archaeological authority before works can proceed. They will also work with the HDC, Iwi Representative(s) and Police to identify appropriate processes.

3. Iwi have an important role as kaitiaki in the care and management of kōiwi following discovery. There are kawa and tikanga considerations that iwi will guide in the event of a discovery of this nature.

4. As soon as practicable after the HDC has given notice to the New Zealand Police through the local police station, the Project Archaeologist, HNZPT Regional Archaeologist and Iwi Representative(s) that kōiwi/human remains have been discovered, the HDC shall invite these parties to meet to discuss the next steps.

5. If the remains are of Māori derivation there are a number of sensitive issues to work through including: any cultural ceremonies; the possibility for the remains to stay where they are; if a disinterment license is required from the local Public Health Unit; what protocols will be followed for the removal of the remains if in situ preservation is not possible; the final location of the remains; the level of recording and extent of any further scientific analysis; and who will remove the remains.

6. The HDC, in consultation with Iwi Representative(s), shall make the necessary arrangements for any cultural ceremonies as soon as practicable.

7. Once these ceremonies are completed, the HDC shall arrange for the Project Archaeologist, in consultation with the New Zealand Police, HNZPT Regional Archaeologist and Iwi Representative(s) to proceed as agreed with potential recording, further analysis, in situ retention or

exhumation in a manner that meets professional standards and the New Zealand Archaeological Association code of ethics.

8. If the remains are of non-Māori derivation it will need to be established: whether any descendants can be traced; whether a disinterment license is required from the local Public Health Unit; where remains will be reburied; and what level of recording and scientific analysis should be undertaken.

9. The Project Archaeologist will record details of the kōiwi/human remains, the site of discovery, and any other relevant facts, and these records will be made available to the New Zealand Police, HNZPT, and Iwi Representative(s) or other descendants.

Custody of Taonga (Excluding Kōiwi / Human Remains) or Material Found at an Archaeological Site

1. The Project Archaeologist will have initial control of, and responsibility for, all material contained in the discovery area.

2. The HDC shall ensure no objects are removed from the site until it has been determined, in consultation between the Project Archaeologist and the Iwi Representative(s), whether it is associated with an archaeological site and/or the object are taonga (be it taonga tūturu as defined in the Protected Objects Act 1975 or otherwise).

3. If the object is of Māori origin the Project Archaeologist will record the object and its context, and, if it is a taonga tūturu, will also notify the Ministry for Culture and Heritage of the finding as required under the Protected Objects Act 1975.

4. Where statutory acknowledgement areas exist, following Treaty Settlement, the Accords between the Crown and Iwi may oblige the HDC to directly notify Iwi of taonga tūturu finds and to transfer these finds for temporary custodianship until ownership is determined. If this situation arises, the Māori Land Court makes the final determination on ownership of all taonga tūturu.

5. If the object is a taonga and less than 50 years old (i.e., not taonga tūturu), the HDC shall invite the appropriate Iwi Representative(s) to remove the taonga from the site.

6. If the object is European in origin the Project Archaeologist shall deliver any such object to the HDC.


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