TE RŌPŪ MATATAU

CONNECTED IN THINKING AND ACTION

MOTT MACDONALD

GHD

Boffa Miskell

Feasibility Study Report

NZ Battery Project, Lake Onslow Pumped Storage Scheme

Volume 8 - Appendix M

September 2022

CONFIDENTIAL

Contents

Volume 8

Appendix M

Environmental Impact Statement

Mott MacDonald
Level 5, 139 The Terrace
6011
Wellington Central
Wellington
New Zealand

mottmac.com

Ministry of Business,
Innovation and Employment
Defence House
15 Stout St
WELLINGTON
6011
New Zealand

Environmental Impact Statement

NZ Battery Project, Lake Onslow PSS: Phase 1B Feasibility Study

September 2022

Confidential

Mott MacDonald New Zealand Limited
Registered in New Zealand no. 3338812

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	02/09/2022	s 9(2)(a)			Environmental Impact Statement for Feasibility Study

Document reference: | NZBLO-TRM-01B-010-RPT-ENV-000503-A

Information class: Standard

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it.

Contents

Tables

Figures

Executive summary

Key findings

Given the preliminary stage of design, limitations on access to affected land and a confined environmental assessment scope and timeframe, this Environmental Impact Statement (EIS) does not provide a comprehensive assessment of all environmental effects likely to arise from the construction and operation of a pumped hydro storage scheme at Lake Onslow (project), nor does it set out in detail the positive benefits of the project in terms of its contribution to resolving Aotearoa New Zealand's dry year electricity generation risk and/or the overall climate benefits of reducing reliance on non-renewable energy sources.

What it does do is provide a comprehensive outline of the key environmental features and values likely to be affected by the project, together with an assessment of the significance of those effects.

Within that context, the key findings of this EIS are:

Inundation of Lake Onslow

The project requires the inundation of up to 7100 hectares (ha) of land and a number of streams and rivers to create an enlarged Lake Onslow.[1]

Approximately 6550ha of that inundated land is held by private landowners and the Central Otago District Council.

Up to 46ha of inundated land is conservation (stewardship) land in the southeast portion of the Manorburn Conservation Area. The balance of the conservation land is marginal strips.

Much of the inundated land (and existing streams and rivers) contains high to very high mana whenua, ecological, conservation and archaeological values.

The creation of the enlarged Lake Onslow is therefore expected to result in:

- The loss of up to approximately 1300ha of important wetland ecosystems including:
  - The loss of 526ha of the Fortification Creek wetland complex which is considered to be nationally significant based on its size, intactness and diversity of plant species. It is also identified as an area of Significant Natural Value for its indigenous biodiversity characteristics.
  - The loss of 94ha of the Boundary Creek Fen, which is regionally significant based on its high degree of naturalness.
  - The loss of 65ha of Middle Creek wetland, which is regionally significant based on its high degree of naturalness.
- The loss of and/or disruption to habitats of Threatened plant and animal species. Specifically:
  - Nationally Threatened or At Risk species of fish and lizard, including:
    - Threatened-Nationally Critical: Teviot flathead galaxias

[1] Based on the project description provided to the environmental specialists in May 2022. As at the design freeze in July 2022, this number is now 7000ha

    - Threatened-Nationally Endangered: Burgan skink, dusky galaxias
    - At Risk-Declining: southern grass skink, Otago green skink, korero gecko.
  - Nationally Threatened plant species:
    - Threatened-Nationally Critical: kettlehole cudweed *Pseudognaphalium ephemerum*, turf cress *Cardamine mutabilis*, saltgrass *Puccinellia raroflorens*, salt-pan cress *Lepidium kirkii*, *Simplicia laxa*
    - Threatened-Nationally Endangered: *Hypericum rubicundulum*, *Chaerophyllum colensoi var. delicatulum*, *Crassula multicaulis*, dryland cress *Pachycladon cheesemanii*
    - Threatened-Nationally Vulnerable: New Zealand mousetail *Myosurus minimus* subsp*. novae-zelandiae*, climbing broom *Carmichaelia kirkii*, Grassy mat sedge *Carex inopinata*, *Ranunculus ternatifolius*, *Sonchus novae-zelandiae.*
  - Nationally Threatened or At Risk bird species:
    - Threatened-Nationally Endangered: black fronted tern *Chlidonias albostriatus*
    - Threatened-Nationally Vulnerable and Taoka species in the Ngai Tahu Claims Settlement Act 1998: Paarere - grey duck *Anas superciliosa*, kaarearea-eastern falcon *Falco novaeseelandiae*, kaamana-southern crested grebe *Podiceps cristatus australis*
    - At Risk-Declining: black-billed gull *Chroicocephalus bulleri*, banded dotterel *Charadrius bicinctus*, New Zealand pipit *Anthus novaeseelandiae*, South Island pied oystercatcher *Haematopus finschi.*
- The loss of approximately 99.5% of the trout spawning habitat in the tributaries to Lake Onslow with a subsequent reduction in trout productivity leading to a significant adverse effect on the population of brown trout and on Lake Onslow as a recreational angling resource.
- The loss of eight recorded archaeological sites within the proposed inundation area, including one assessed as having 'high' significance and five as having 'medium' significance with a further six recorded archaeological sites within 1km of the inundation area likely to also be adversely impacted. Other archaeological sites and heritage features may also be impacted depending on final design.

Lake Onslow water level fluctuation

The operation of the Lake as a hydro battery will result in significant fluctuations in lake levels.

Those fluctuations will result in:

- A very high adverse impact on the landscape character of the East Otago Uplands (which includes a Landscape Management Area and part of an Outstanding Natural Landscape)
- A significant adverse effect on the use of lake as a recreational angling destination
- Significant adverse effects on other recreational activities such as cycling and walking
- The loss of submerged plant species from the Lake.

Wetland ecosystems and other habitats will not re-establish around the new Lake margins because of the fluctuations in lake levels.

Lake Onslow dam structure

The project will require the development of a dam structure and associated infrastructure.

That dam structure and associated infrastructure will:

- Require the diversion of Te Awa Makarara/Teviot River during construction (approximately 4–5 years)
- Result in a very high adverse impact on the natural character of the East Otago Uplands (which includes a Landscape Management Area and part of an Outstanding Natural Landscape).

Lower reservoir: offtake and intakes

The project will require the development of offtake and intake infrastructure at either s 9(2)(i) [redacted]

s 9(2)(i) [redacted] The infrastructure for the offtake option would result in:

- The loss of a significant area of the plant species makahikātoa (Threatened-Nationally Vulnerable)
- Direct impacts on, including potential acquisition of, privately owned land, Crown land and land owned by the Central Otago District Council.

If s 9(2)(i) [redacted] is selected as the preferred offtake option, that infrastructure would result in:

- The loss of four recorded archaeological sites
- The loss of habitat for Threatened lizard species
- The loss of Land Use Capability (LUC) 3 soils which may be considered to be 'highly productive'
- s 9(2)(i) [redacted]

If s 9(2)(i) [redacted] is selected as the preferred offtake option, that infrastructure would result in:

- The loss of four recorded archaeological sites
- The loss of habitat for Threatened lizard species
- The loss of LUC 3 soils which may be considered to be 'highly productive'
- Direct impacts on, including potential acquisition of, privately owned land, as well as land owned by the Crown and the Central Otago District Council.

Project outflows below the Roxburgh Dam

If the project utilises an outflow below the Roxburgh Dam, the operation of the project will result in greater variability of river flows in the lower Mata-Au/Clutha River below the selected abstraction/discharge location.

This may result in adverse impacts on water quality and aquatic ecology of the lower Mata-Au/Clutha River.

This will result in adverse impacts on river use including angling, white water activities and the operation of the Tuapeka Mouth Ferry.

What those findings mean for the project

Overall, these findings indicate that, while the project may deliver significant and highly valuable benefits to the people and communities of Aotearoa New Zealand, those benefits will come at the loss of important wetlands, fish and plant species which are unlikely to be fully replaceable.

Specifically, the unavoidable loss of regionally and nationally significant, extensive, diverse, and rare wetlands is one of the most significant adverse effects of the project, which will require a focus on protecting and enhancing other similar wetlands in the local landscape as part mitigation, and, critically, accepting a net loss of wetland extent nationally. This is inconsistent with national policy direction on the retention of remnant wetlands (from the National Policy Statement for Freshwater Management) which requires the avoidance of any further loss of natural wetlands. This direction responds to analysis which shows that approximately 90% of Aotearoa New Zealand wetlands have been drained since human settlement and that between the period 2001-2016, at least 214 individual wetlands with an area of 1247ha were lost.[2]

As a result of the necessary inundation of land and waterways and the significant loss of habitat, several species of Threatened or At Risk plants and animals will be adversely impacted. In particular, the fish, Teviot flathead galaxias, a Threatened–Nationally Critical species that only lives within the Te Awa Makarara/Teviot River catchment, would be at risk of significant population loss, with up to 13% of its habitat inundated and a further 67% likely to be otherwise impacted by the project (82% of all known habitat lost or otherwise impacted).

Potential management of these effects on freshwater values could include a range of remediation and offsetting actions including translocations, stream restoration in tributaries, enhancement of fisheries elsewhere, and a national level biosecurity compensation payment; however, it is noted that the success of these measures could not be guaranteed. Plant translocations are recommended to be attempted for species within the impacted wetland and terrestrial habitats; the analysis finds this measure potentially feasible for 34 of the 47 notable plant species potentially affected by the project.

Maintaining good water quality in all of the remaining waterbodies, including in the enlarged Lake Onslow and in the Mata Au/Clutha River, will be important to the success of mitigating and offsetting effects on freshwater values. The design and operating regime of the project will therefore be crucial in supporting this outcome, including in endeavouring to exclude pest and fish species from being transferred between the Mata Au/Clutha River and Lake Onslow to the extent possible.

Loss of lake margin habitat will create a key adverse effect on Threatened and At Risk birds, including the loss of foraging, roosting, and breeding habitat. Important habitats for Threatened and At Risk species of lizards will also be disrupted, with the key lizard species at the site, the Burgan skink, at most risk. Although more work is required on knowledge about this species, it is considered possible to mitigate and offset adverse effects on this and other lizards, through a combination of creating new rock outcrop habitat, protection and enhancement of existing tussock grassland and rock outcrop habitat, and construction of predator-proof fencing for Burgan skink at an off-site location.

Adverse effects on terrestrial invertebrates are recommended to be addressed through salvage and relocation together with habitat creation, and protection and enhancement of tussock grassland and rock outcrop habitat. Adverse effects on freshwater biodiversity can likely be addressed through lake margin enhancement both within the enlarged Lake Onslow and at

---

2 Ministry for the Environment & Stats NZ (2020). *New Zealand's Environmental Reporting Series: Our Freshwater 2020.*

similar off-site lakes, enhancing off-site streams and the Te Awa Makarara/Teviot River below the proposed dam, and avoiding introduction of pest organisms.

The likely total loss of a highly productive trout fishery at Lake Onslow is unavoidable, although opportunities exist to improve the fishing experience at other lakes in the Mata-Au/Clutha River catchment in other locations to compensate for this.

s 9(2)(g)(i) [redacted]

The expected impacts on the natural and physical resources and habitats of the area are highly significant to mana whenua, with much of the project area holding important cultural values related to waterbodies, wetlands, indigenous freshwater and terrestrial species and habitats, as well as various wāhi tupuna (*ancestral landscapes*), ara tawhito (*traditional travel routes*) and sites of archaeological significance. In particular, wai (*water*) is considered to be a taoka (*treasure*) of 'extreme significance' to Kāi Tahu with the mauri of water acting as a life-giving force, connecting the environment from the mountains to the sea. When the health and mauri of waterways are degraded or diminished, the impacts are far reaching not only for the waterway, the ecosystems, the habitats and species it supports, but also for its people. Further work is necessary to understand the extent to which the loss of mana whenua values can be adequately mitigated by the measures proposed.

While the impacts on natural resources will be widespread and, in some cases, unavoidable and irreversible, significant social disruption is also an anticipated consequence of the project, particularly for the most directly impacted landowners, as well as resulting in increased pressure on essential infrastructure, community services and recreational pursuits for the balance of the community. Such impacts may be offset by other benefits and gains to the relevant communities, including increased employment opportunities, and improvements to accommodation and services. Further work will need to be undertaken with affected communities to determine how best those impacts can be balanced and managed.

The Gap Analysis[3] completed in June 2022 identified a range of information gaps and recommended priority areas of investigation to better inform decision-making on progression or otherwise of the project. While some of that work has been able to be completed, significant information gaps remain. That said, as set out in that original report "it is considered unlikely those investigations will reveal impacts on environmental values that are of a greater or higher magnitude than the already known findings". That position is confirmed in this EIS.

While it is possible that further investigations may reveal additional significant environmental values and features which will be adversely affected by the construction and operation of the project, it is unlikely that the effects already identified and outlined above will be eliminated or significantly reduced as a result of any such further work. As such, the scope of work completed to date (while necessarily constrained) provides sufficient confidence that the nature and scale of the project is such that it will inevitably result in significant adverse effects on important environmental values. Given the size and scale of development necessary to deliver a project of this nature, that can be expected to be the case, irrespective of the location chosen.

Given the above, careful consideration has been given to not only to the environmental impact of the project but to its ability to gain the necessary consents and authorisations. A Consenting Strategy detailing those matters has therefore been prepared and is attached as Appendix L to the Feasibility Study Report (Te Rōpū Matatau, NZBLO-TRM-01A-010-RPT-CON-000430-C,

[3] Te Rōpū Matatau. (2022). *Gap Analysis Report* (NZBLO-TRM-01A-010-RPT-ENV-000354-C)

2022)**.** By way of summary, that strategy finds that the existing legislative framework (as set out in Chapter 18: Legislative context) establishes a range of environmental values of significance which will be materially affected by the project. Given the significance of these matters there is a considerable risk that even with mitigation, environmental off-setting and/or compensation in place, a decision maker may determine that the adverse effects of the project on those values are too high, particularly given the legislative and planning framework within which that decision is to be made (primarily the Resource Management Act 1991 (RMA)) does not specifically elevate broader climate outcomes over those matters. This is particularly the case in the immediate to short term, where although legislative reform and national policy direction is increasingly overt about the need for nationally significant infrastructure being provided with exemptions from certain environmental protections or needing alternative consenting pathways and frameworks, (particularly renewable energy generation projects and projects which contribute to Aotearoa New Zealand's climate adaptation obligations), that framework is not yet fully in place and is unlikely to be within the timeframes required for the project.

Within that context and if the project is to begin construction as soon as possible, the only sufficiently timely and certain option for obtaining the necessary consents is to put in place a project specific decision-making process by way of bespoke legislation. Such legislation would need to provide the project with an altered decision-making framework which reflects the importance and urgency of Aotearoa New Zealand's climate response and provides an appropriate weighting for the benefits of the project in responding to those climate challenges. In effect, such legislation would bring forward the expected outcomes of legislative reform and national policy direction currently underway.

1 Introduction

The NZ Battery Project is a government initiative designed to investigate options for resolving Aotearoa New Zealand's dry year risk problem. Currently, in years where Aotearoa New Zealand's existing hydro-power catchments receive insufficient rainfall or snowmelt to ensure adequate levels in the hydropower storage lakes, some form of additional or 'back-up' generation is needed. This is currently provided by fossil fuel generation (coal and gas). As Aotearoa New Zealand looks to transition away from fossil fuels, alternative solutions are required.

In this regard, the Interim Climate Change Committee (ICCC) has recommended that a more detailed analysis of some options, particularly large pumped hydro storage, is undertaken to determine the feasibility of eliminating the use of fossil fuels in the Aotearoa New Zealand electricity system.

1.1 Overview of pumped hydro schemes

Pumped hydro schemes are used internationally as a way of storing and using water independently of natural inflows. Such schemes are able to be specifically designed to meet daily demand peaks and/or store a large amount of water for a long period to meet dry year energy storage requirements. As such, they present a potential alternative solution to the back-up fossil fuel generation used in Aotearoa New Zealand currently.

Pumped hydro schemes typically consist of a lower water resource or reservoir and an upper storage reservoir. During periods of high electricity supply/low electricity prices, water is pumped to the upper reservoir and stored. During periods of high electricity demand and/or low levels of alternative renewable generation, water can be released from the upper reservoir into the lower water resource and/or lower storage reservoir to generate electricity.

1.2 Lake Onslow pumped hydro scheme feasibility study

Consistent with the recommendation of the ICCC, the Ministry for Business, Innovation and Employment (MBIE) is investigating the feasibility of a pumped hydro storage scheme in Aotearoa New Zealand as part of the wider NZ Battery Project assessment.

The scheme would expand an existing artificial water storage reservoir, Lake Onslow, located in the Onslow-Manorburn depression in Otago, to provide long-duration water storage to provide additional hydroelectricity generation during extended dry (or cloudy) periods.

As set out in detail in **Chapter 2: Project description**, the main components of a pumped hydro storage scheme at Lake Onslow would include:

- An upper dam and reservoir based around the existing Lake Onslow
- A lower offtake and reservoir associated with the Mata-Au/Clutha River
- Tunnels, shafts and an underground powerhouse
- Connections into the electricity supply network and associated infrastructure, access and earthworks.

The feasibility study addresses the geotechnical, geological, hydrogeological, consenting and environmental constraints of the proposed Lake Onslow pumped hydro scheme in order that it can be compared to other storage technologies being assessed as part of the wider NZ Battery Project. A decision will then be made on whether to progress to a more detailed analysis of this option.

1.3 Purpose of the Environmental Impact Statement

The EIS supports the feasibility study by outlining and assessing:

- The known baseline environmental characteristics and values in the area
- The potential adverse impacts of the project on those environmental values and features
- Any options to avoid, remedy, mitigate, or offset and/or compensate those potential adverse impacts
- Any opportunities to improve or enhance those environment values and features
- The significance of those impacts, both positive and negative, for progressing the project

The EIS identifies existing knowledge gaps in relation to the baseline environmental characteristics and values and makes a range of recommendations as to further work required to meet those knowledge gaps and fully quantify the potential environmental impacts of the project.

The EIS also sets out the relevant existing legislative and planning environment relevant to the project (**Chapter 18: Legislative context)** and identifies matters of value and significance to the community as evidenced by the relevant statutes, plans and policy documents. Given the early stage of project development and feasibility assessment, the EIS does not specifically assess the project against each relevant rule, objective and policy of that legislative and planning framework. It does, however, consider the overall 'direction of travel' established by the framework to inform the assessment of the extent to which the project is consistent or otherwise with that direction of travel. That assessment is found in the Consenting Strategy (Te Rōpū Matatau, NZBLO-TRM-01A-010-RPT-CON-000430-C, 2022) which has been prepared to consider options for authorising the project, should a decision be made to progress it.

1.4 Approach to assessment

A series of initial environmental reports commissioned by MBIE were prepared in 2021 and early 2022 to determine the existing environmental values and features of the project area. These reports largely focused on the area immediately around Lake Onslow and were prepared at a time when limited information about the project was available. These reports were subsequently updated where possible to analyse the project more specifically as per the project description set out in **Chapter 2: Project description**. These updated reports are appended in **Volume Two** of the EIS.

Along with the environmental reports, this EIS has been informed by a series of technical reports prepared by the Te Rōpū Matatau team, and draws on publicly available information such as GIS data, statutory documents and published reports and commentaries. These information sources are cited within the various chapters below, and a full reference list is provided as **Chapter 20: References**.

The environmental reports undertaken are, however, still at varying degrees of specificity with some reports able to provide comprehensive data while others were constrained by a lack of information. s 9(2)(i) [redacted] Moreover, in some instances, insufficient detail as to the project arrangement means that a full assessment cannot be yet undertaken.

The EIS acknowledges these information gaps and, to the extent possible, provides some commentary on the significance of these gaps to the stage of decision-making.

In that regard and for completeness, it is important to note that this EIS is not an Assessment of Environmental Effects (AEE) as is typically prepared for a resource consent application or other authorisation under the Resource Management Act 1991. Rather, it outlines the baseline values of the environment based on the information and technical analysis available, and the potential impacts of the project as known at this stage of the project. It then seeks to quantify the significance of those impacts. A comprehensive AEE would be required to accompany any application for consent.

2 Project description

Technical specialists commissioned to complete the environment reports were provided with a description of the pumped hydro storage scheme on 31 May 2022 by way of a project description. That description, included as **Appendix A, Volume Two**, provided the basis for those assessments of the project's potential impacts on the baseline environmental characteristics/values. Within this EIS, the *project* therefore references the pumped hydro scheme as described in that Appendix. The following presents a summary of the key elements of the project including its construction, and the project's operating regime, details of which are provided in **Appendix A, Volume Two**.

This chapter also provides a high-level summary of the main design changes that have occurred since 31 May 2022 (through to the 'design freeze' in July 2022) and identifies any limited implications those changes may have for the identified impacts of the project as assessed by the technical specialists.

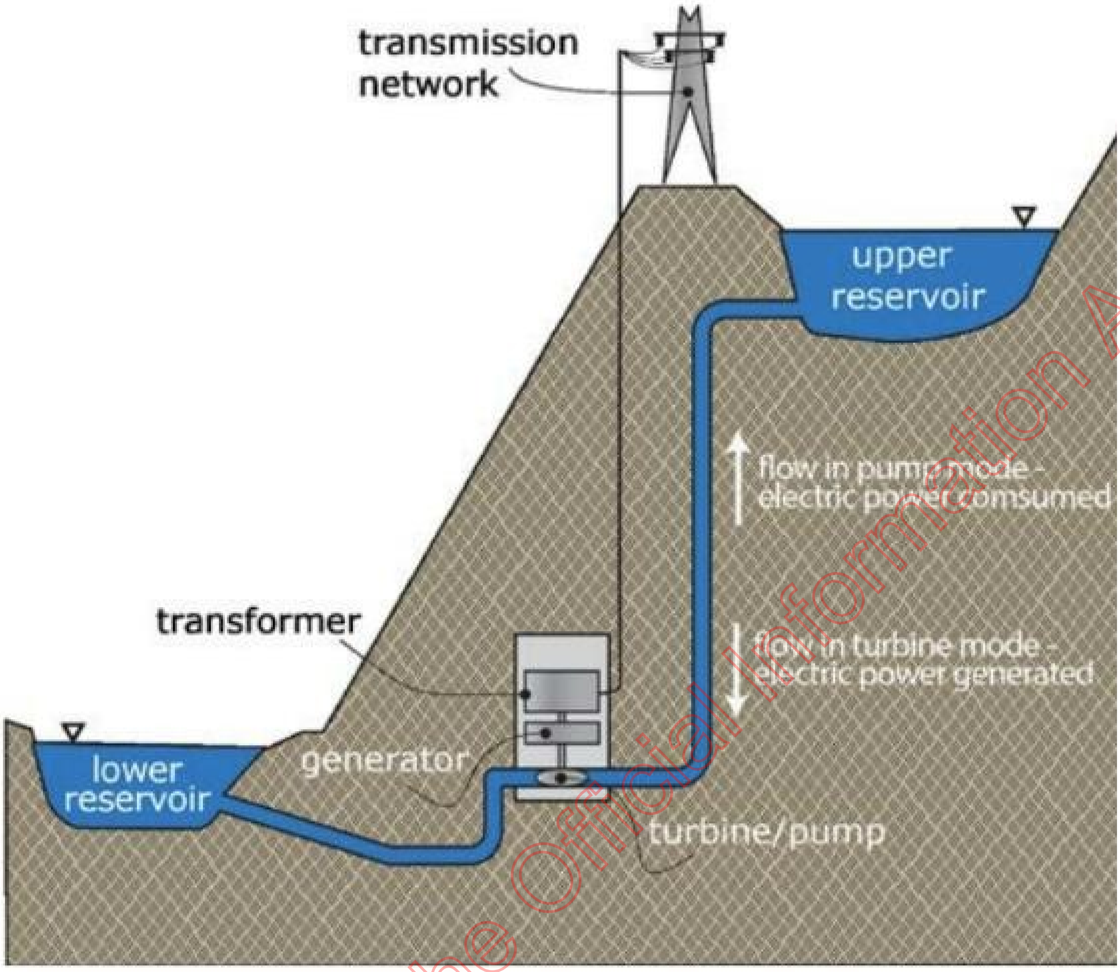
2.1 The project

The project would consist of the following key components:

- An upper reservoir which stores water that is used to generate electricity (Lake Onslow)
- A dam to create the upper reservoir (on Te Awa Makarara/Teviot River)
- A source of water to fill the upper reservoir (Mata-Au/Clutha River)
- A lower offtake from the Mata-Au/Clutha River to harvest water (at either s 9(2)(i) [redacted]
- A storage reservoir beside the Mata-Au/Clutha River to store the harvested water (the lower reservoir), developed at one of three sites: s 9(2)(i) [redacted]
- Intakes/outlets within Lake Onslow to transfer water between Lake Onslow and the lower reservoir
- Intakes/outlets within the lower reservoir to transfer water between the lower reservoir and Lake Onslow
- An underground tunnel (waterway) to transfer water between the lower offtake and Lake Onslow
- An underground powerhouse to:
  - generate electricity with water coming down from Lake Onslow as it passes into the lower reservoir; and
  - pump water up to Lake Onslow.
- Supporting infrastructure including roading, accommodation, transmission lines and water supply required for the construction phase.

A brief description of each of these components (illustrated in Figure 2.1) is set out below. Details of the construction and operation of the project are provided in **Appendix A, Volume Two**.

Figure 2.1: Pumped Hydro Scheme Elements (illustrative concept only)



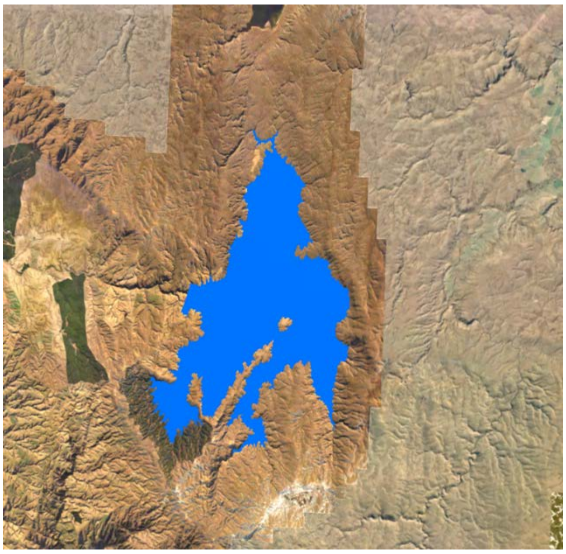
Source: Viadero, R., Rehbein, M. and Singh, A. (2017). *Hydropower on the Mississippi River*.

2.1.1 Upper reservoir (Lake Onslow)

The upper reservoir would store water to be used for generating electricity. It would be established by constructing a new dam across the Te Awa Makarara/Teviot River, then pumping water from the lower reservoir or the Mata-Au/Clutha River to expand the existing waterbody.

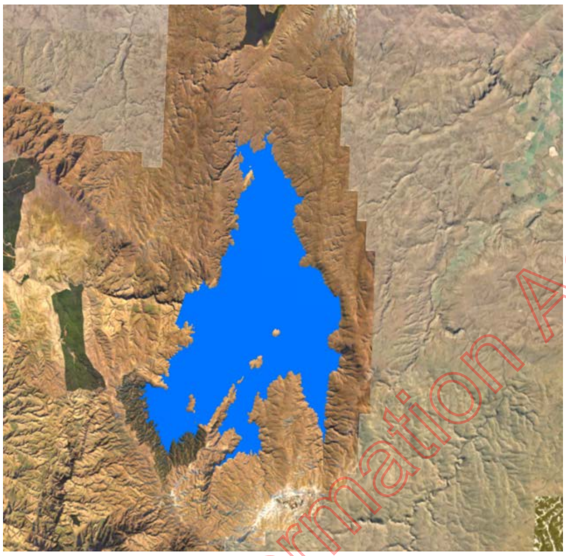
The maximum size of the upper reservoir will be determined by the selected overall energy storage of the scheme. The maximum energy storage of the scheme is likely to be between 3TWh and 5TWh (illustrated in Figure 2.2 and Figure 2.3), with the corresponding upper reservoir characteristics listed in the table below.

Figure 2.2: Lake Onslow proposed full supply level – 3TWh storage (745mRL)



Source: Te Rōpū Matatau

Figure 2.3: Lake Onslow proposed full supply level – 5TWh storage (765mRL)



Source: Te Rōpū Matatau

Table 2.1: Upper reservoir characteristics

Characteristic	3TWh option	5TWh option
Full supply level (FSL)	745mRL[4]	765mRL
Minimum operating level (MOL)	695mRL	695mRL
Operating range	50m	70m
Maximum reservoir area	59Mm^2 / 5900ha	71Mm^2 / 7100ha
Maximum reservoir volume	2372Mm^3	3676Mm^3

Source: Te Rōpū Matatau

For the purposes of the EIS, it is assumed that:

- The maximum harvesting flow from the Mata-Au/Clutha River will be 250m^3/s
- The maximum rate at which water will be discharged into Lake Onslow will be 250m^3/s
- If there is a new lower reservoir, there is the potential for this to moderate return flows to the Mata-Au/Clutha River
- The reversible pumps/turbines can potentially ramp from no load to a full load in 20-30 seconds, and vice versa.

2.1.2 Dam

The proposed upper reservoir will be formed with a new dam located a short distance downstream of the existing Lake Onslow dam on Te Awa Makarara/Teviot River (refer Figure 2.4).

The characteristics of the dam for both of the upper reservoir storage options are illustrated in Table 2.2 below.

4 mRL: metres Reference Level, which used to measure elevation.

Table 2.2: Dam heights and footprints

Characteristic	3TWh option	5TWh option
Dam height (m)	85	105
Dam footprint (m^2)	77,000	175,000
Dam length (m)	1500	2600

Source: Te Rōpū Matatau

2.1.3 Lower offtake

The lower offtake is the means by which water is harvested from the Mata-Au/Clutha River to feed into the project. It is also the location at which water from the project is discharged back into the Mata-Au/Clutha River when the project is generating electricity.

There are three potential locations for the lower offtake:

s 9(2)(i)

- [redacted]

Figure 2.4 shows the locations of these options, and Figure 2.5, Figure 2.6 and Figure 2.7 show the offtake options in more detail.

s 9(2)(i)

Once the water is harvested from the river, it will either be pumped directly up to Lake Onslow (in the case of the Lake Roxburgh offtake) or stored in a new off-river reservoir constructed adjacent to the Mata-Au/Clutha River (in the case of the s 9(2)(i) [redacted] offtake locations).

Water will be harvested from the River either using gravity flow, or by pumping the water to a slightly higher elevation using a lower pumping station.

All offtake structures from the Mata-Au/Clutha River are assumed to be provided with fish screens.

s 9(2)(i) [redacted]

s 9(2)(i)

[redacted]

s 9(2)(i)

[redacted]

s 9(2)(i)

[redacted]

s 9(2)(i)

s 9(2)(i)

[redacted]

3 Overall description of the project area

The project would be accommodated within three adjoining locations within the Central Otago region:

- Lake Onslow and its surrounds
- The Teviot Valley
- Lake Roxburgh or the Mata-Au/Clutha River Valley area (depending on the offtake location)

For the purposes of this EIS, the *project area* generally refers to the spatial extent of the project components within these locations and their immediate surrounds.

The brief description of these locations is included below.

3.1 Lake Onslow and surrounds

Lake Onslow is located approximately 25km east of Roxburgh in Central Otago. First dammed in 1890, it is a human-made water reservoir created by the damming of the Te Awa Makarara/Teviot River for gold mining, hydroelectricity generation and irrigation storage, sitting within a natural depression. The current dam at the head of the Te Awa Makarara/Teviot River was built in 1982, creating a larger lake and drowning the older dam.

The Lake is used for water storage for five downstream power stations operated by Pioneer Energy, with resource consents permitting water to be discharged at a rate of up to six cubic metres per second[5]. Although water levels fluctuate, the Lake is on average approximately 380 hectares in area, 10m deep and sits approximately 700 metres above sea level (mASL).

Lake Onslow is fed from a number of small tributaries, including the southern and northern branches of Te Awa Makarara/Teviot River, with a total catchment area of approximately 126km^2. The catchment predominantly comprises high-country tussock and pasture for grazing.

The surrounding landform at Lake Onslow is characterised by a wide basin with broad ridges surrounding the catchment. Te Awa Makarara/Teviot River gorge is located to the west of Lake Onslow. Land within the Onslow Basin and surrounding environs is either pastoral lease or privately owned. Wetlands of national significance are located on the southern side of Lake Onslow. The Manorburn Conservation Area lies to the northwest and is 2867ha in area. Other conservation land in the area comprises marginal strips that exist adjacent to the various waterbodies.

Reflecting its popularity as a recreational fishing spot, a concentration of anglers huts exist on the southwestern shore of the Lake, either on private land or on the marginal strip around the edge of the Lake. Vehicle access to Lake Onslow is via a Council-owned road from Millers Flat, which is often downgraded to a four-wheel drive track in winter due to snow and ice. This road continues on the northwest side of the Lake through to the Manorburn Conservation Area.

[5] Otago Regional Council consent number 2001.477

s 9(2)(i)

3.2 Teviot Valley

The main stem of Te Awa Makarara/Teviot River flows westwards from Lake Onslow through a narrow gorge, joining the Mata-Au/Clutha River at Roxburgh. The valley containing the Mata-Au/Clutha River between Roxburgh downstream to Millers Flat is known as the Teviot Valley, named after the original pastoral farming station that covered the district.

Te Awa Makarara/Teviot River has a large height difference of approximately 600m over the 30km distance between Lake Onslow and its confluence with the Mata-Au/Clutha River. Pioneer Energy operates a number of dams in the area, including Onslow Dam described above, the Horseshoe Bend Dam (located about halfway between Lake Onslow and the Mata-Au/Clutha River) and the Marslin Dam (located closer to the Mata-Au/Clutha River). A windfarm also operated by Pioneer Energy is located adjacent to the Horseshoe Bend Dam and comprises three 69m high wind turbines (generating approximately 1.9MW).

Water from Lake Onslow discharged to Te Awa Makarara/Teviot River for hydroelectricity generation is also shared with the Teviot Irrigation Company who own and operate a number of water takes along Te Awa Makarara/Teviot River for irrigation purposes. As a result, there are a number of structures, powerhouses and intakes for irrigation along the Te Awa Makarara/Teviot River.

The Mata-Au/Clutha River flows north to south through the Teviot Valley. Originating in the Southern Alps and flowing around 340km through Otago before discharging to the Pacific Ocean at Molyneaux Bay, south of Balclutha, the Mata-Au/Clutha River catchment is the largest river catchment in Aotearoa New Zealand, covering an area of 21,400m^2.

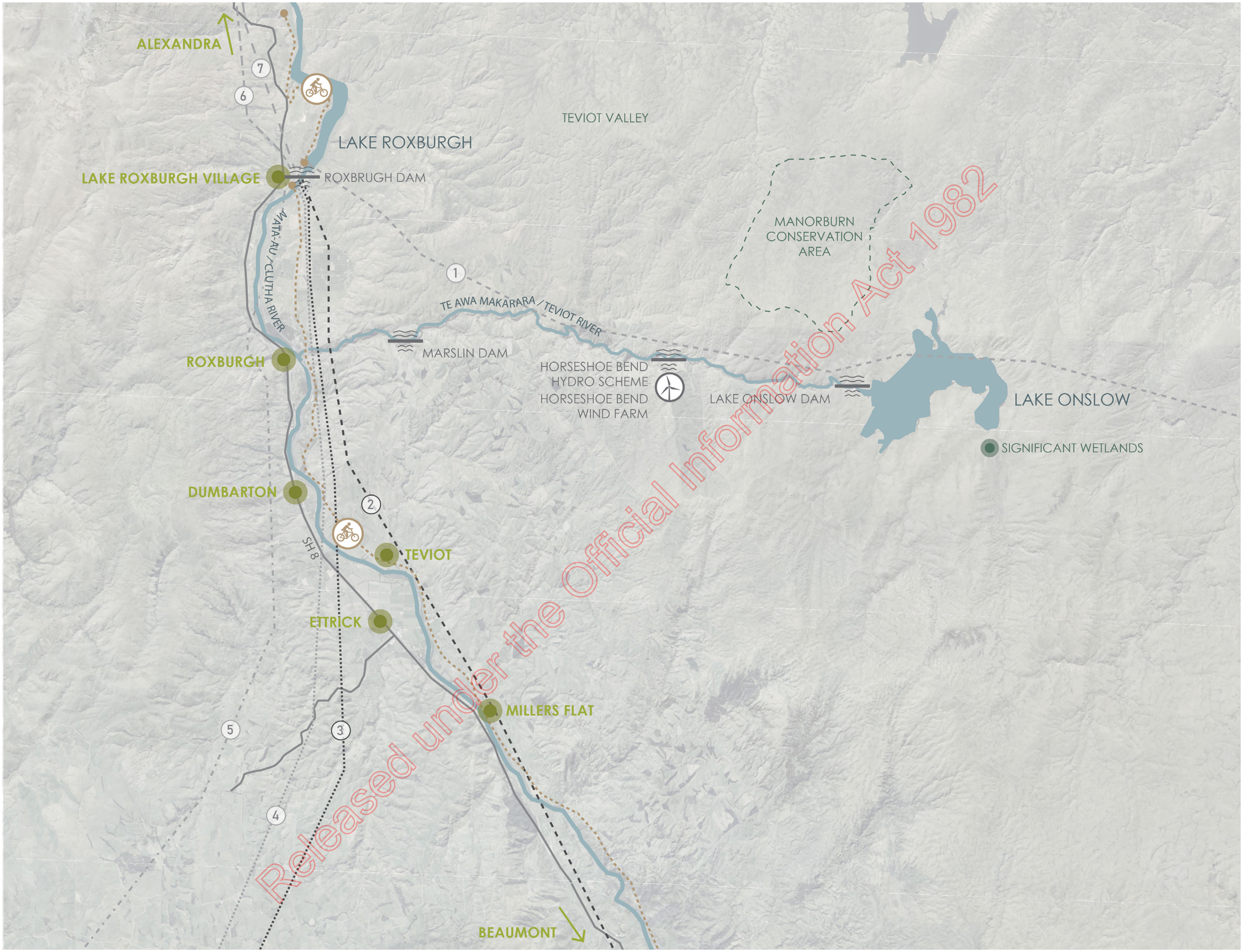
There are three dams along the Mata-Au/Clutha River: at Hāwea, Clyde and Roxburgh, with the Clyde and Roxburgh dams including significant hydroelectric power stations with installed generating capacity of 432MW and 320 MW respectively[6]. There are also other smaller hydroelectric power stations that operate in tributaries of the River, including those in the Teviot catchment.

High voltage transmission lines forming part of the National Grid extend east from the Roxburgh Dam and cross the northern side of Lake Onslow (Roxburgh-Three Mile Hill A 220kV transmission line). A series of transmission lines forming part of the National Grid are also located in the vicinity of the Mata-Au/Clutha River. These include the Halfway Bush – Roxburgh A 110kV transmission line; Gore-Roxburgh A 110kV, Invercargill-Roxburgh A 220kV transmission line, and Invercargill-Roxburgh B 220kV transmission line. A substation is located at Roxburgh.

Other than power generation, land use in the Teviot Valley includes horticulture, orchards, farmland, forestry and residential activities. Pastoral farming and horticulture are stated to be the principal economic activities of the Valley, with summer fruit and pip fruit also being important industries.

The Teviot Valley is home to a number of small settlements including Lake Roxburgh Village, Roxburgh, Dumbarton, Ettrick and Millers Flat. These are connected by State Highway 8 which follows the Teviot Valley often close to the Mata-Au/Clutha River. The Roxburgh Gorge and Clutha Gold Trails follow the Mata-Au/Clutha from Lake Roxburgh to Lawrence.

[6] Contact Energy. (2022). Our Powerstations. https://contact.co.nz/aboutus/our-story/our-powerstations#:~:text=The%20Clyde%20Dam%20on%20Lake,its%20four%20turbine%20generator%20units



NTS: Diagram intended for schematic/illustrative use only

N

TE RŌPŪ MATATAU
CONNECTED IN THINKING AND ACTION

Legend
Transmission Lines
1 ROX-TMH-A
2 HWB-ROX-A
3 GOR-ROX-A
4 INV-ROX-A
5 INV-ROX-B
6 ROX-TWZ-A
7 ROX-ISL-A

Ministry of Business, Innovation & Employment
NZ Battery Project: Lake Onslow Pumped Hydro Storage Option

3.2 Teviot Valley environs

File Ref: BM210219_Values_Diagrams_Titleblock.indd
Print date: 01 Sept 2022

Reviewed: DRo
Created by: EFa

3.3 Mata-Au/Clutha River offtake options

3.3.1 s 9(2)(i) [redacted] offtake option

The area proposed for a potential offtake s 9(2)(i) [redacted]

s 9(2)(i) [redacted]

[redacted]

[redacted]

s 9(2)(i)

[redacted]

s 9(2)(i)

s 9(2)(i)

[redacted]

3.3.3 s 9(2)(i) [redacted] offtake option

s 9(2)(i) [redacted] offtake option, s 9(2)(i) [redacted]

[redacted]

s 9(2)(i)

4 Cultural

This chapter is subject to review by Aukaha (1997) Limited.

Three papatipu rūnaka hold shared authority and mana whenua in respect of the project area.

These are:

- Te Rūnanga o Ōtākou
- Kāti Huirapa ki Puketeraki
- Hokonui Rūnanga

(Kā Rūnaka, or mana whenua)

Aukaha (1997) Limited (*Aukaha*) has prepared Cultural Values Statements on behalf of Kā Rūnaka (appended in **Appendix C.1 and C.2 of Volume Two**) which outlines those tangible and intangible aspects of the natural and physical environment within the project area that are of particular value to Kā Rūnaka in and around Lake Onslow the Mata-Au/Clutha River, and Te Awa Makarara/Teviot River. This chapter provides a summary of those values and identifies aspects of the project which may impact those values.

The potential significance of such impacts has not yet been evaluated by Kā Rūnaka given the early stage of the project, and the implications of this for decision-making are discussed at the end of this chapter.

4.1 Mana whenua values within the Lake Onslow area

The following features of the project area are identified to be of significance to Kā Rūnaka:

- Wai (*water*)
- Wetlands
- Wāhi tupuna (*ancestral landscapes of significance to iwi*)
- Ara tawhito (*traditional travel routes*)
- Other archaeological features
- Ecology
- Matters of equity.

The particular significance of each of these features as expressed in the Cultural Values Statement is summarised below. Where appropriate, reference is also made to the broader values, aspirations and objectives of Kāi Tahu in relation to these features which are set out in the relevant regulatory documents (refer **Chapter 18: Legislative context**).

4.1.1 Wai

Wai is a taoka (*treasure*) of 'extreme significance' to Kāi Tahu[7]. As explained in both the Cultural Vales Statement and the Kāi Tahu ki Otago–Natural Resources Management Plan, wai is an early ancestor in the whakapapa of the Kāi Tahu world, enhancing its mana and placing greater responsibility on Kāi Tahu as kaitiaki to protect the wai and all the life it supports.[8]

[7] Aukaha (1997) Limited. (2021). *Cultural Values Statement*, page 26

[8] Aukaha (1997) Limited. (2021). *Cultural Values Statement*, page 10

Central to the action of kaitiakitaka in this respect is mauri, recognised as the force that binds the spiritual and physical aspects of the world that generates and upholds all life. The mauri of water acts a life-giving force, connecting the environment from the mountains to the sea. When the health and mauri of waterways are degraded, the impacts are therefore far reaching not only for the waterway, the ecosystems, the habitats and species it supports, but also for its people.

In circumstances where mahika kai (*practices, knowledge, and activities related to food gathering*) become unsustainable as a result of degradation, opportunities to share stories, practices and histories associated with the waterway also diminish with a subsequent loss of knowledge and connection to place. In these ways the condition of the water is therefore seen as a reflection of the condition of the people.

Kā Rūnaka observe that the period of European settlement in Te Waipounamu has coincided with the degradation of many waterbodies, including Lake Onslow and Te Awa Makarara/Teviot River. In the case of those water bodies, degradation is seen to have come about as a result of damming and inundation and the subsequent loss of wetlands; the incursion of introduced species and plants (including exotic grasses), and other human-related activities. As a result, ancestral sites and mahika kai have been destroyed, which in turn has diminished the sense of connection between mana whenua and this location.

Restoring the taoka values of the water within these bodies, and, for Te Awa Makarara and Lake Onslow in particular, enhancing their role in supporting mahika kai, are therefore areas of significant priority for mana whenua.

4.1.1.1 Wai and the project

The National Policy Statement for Freshwater Management (NPS-F) places Te Mana o Te Wai (as described in **Chapter 18: Legislative context**) at the core of managing freshwater in Aotearoa New Zealand. For Kā Rūnaka, that requires the project to be undertaken in a way which upholds and promotes the mana of waterways.

4.1.2 Wetlands

Wetlands hold significant value for Kāi Tahu both for their role in supporting the health and mauri of freshwater and indigenous biodiversity, and as a readily available food source. Their loss within the Otago takiwā is a matter of particular concern for mana whenua.

By way of example, the Lake Onslow site was once an extensive wetland which was prized by mana whenua for its mahika kai and the mātauraka, tika and kawa that were passed on through generations as tūpuna undertook seasonal migration through this area. That wetland has now been substantially destroyed as a result of the establishment of the existing Lake (through damming), mining and wider modification of the surrounding environment.

While knowledge of mana whenua's connections to Lake Onslow and its values as a mahika kai site have been eroded, clues remain which indicate its value to mana whenua. They include the following three scheduled wetland areas on the southern margins of Lake Onslow and to the south of Te Awa Makarara/Teviot River, which are vestigial remnants of the historic wetlands that were lost with the establishment of Lake Onslow:

- Middle Swamp (identified by the Otago Regional Council as a regionally significant wetland)
- Boundary Creek Fen (also identified by the Otago Regional Council as a regionally significant wetland)
- Fortification Creek Wetland Management Area (identified as a regionally significant wetland by Otago Regional Council, but as nationally significant by Wildlands Consultants Limited[9]).

[9] Refer to Chapter 5: Freshwater for more information on the significance of wetlands in the project area.

4.1.2.1 Wetlands and the project

The Cultural Values Statement references the NPS-F approach to management of wetlands, and in particular, its provisions which aim to prevent any further loss of extent of natural inland wetlands, protect their values, and promote their restoration. For Kā Rūnaka, the protection of wetlands complexes (such as those within the Lake Onslow area), and the indigenous biodiversity they support, is a priority of great significance.

4.1.3 Wāhi tupuna, ara tawhito, and other archaeological features

Reflecting their significance to mana whenua, Lake Onslow, Te Awa Makarara/Teviot River and the Mata-Au/Clutha River have all been mapped as wāhi tupuna as part of the Ngāi Tahu mapping project, Kā Huru Manu. The Mata-Au/Clutha River is further identified as a significant ara tawhito, for its role in linking many wāhi tupuna (including wāhi mahika kai (*food gathering sites*), nohoaka (*temporary campsites*), and kāika (*settlements*) along its route, and allowing generations of ancestors to travel from the coast to the mountains and back again.

Within the RMA documents, Lake Onslow is listed within the Otago Regional Plan: Water for its wāhi taoka values, and as a wāhi mahika kai. Te Awa Makarara/Teviot River is also recognised as a wāhi mahika kai.

In addition to these features/landscapes, there are a number of identified archaeological sites of significance to mana whenua within the project area, including rock shelters (with evidence of moa bone fragments), and ovens/umu tī. Mana whenua are acutely aware that there are likely to be more archaeological sites and artefacts of significance that are discovered if the project progresses.

s 9(2)(i)

[redacted]

s 9(2)(i)

The evidence offered by these sites and artefacts provide further information about tūpuna (*ancestors*) and their daily lives, which in turn strengthens mana whenua values of whakapapa (*genealogy*), mana (*power/authority, ultimately inherited from atua - deity/early ancestor*) and tapu (*sacredness*).

Similarly, these wāhi tupuna and ara tawhito hold particular value for mana whenua because of their role in 'rekindling the fires of ahikāroa' (*authority over an area established through occupation and maintenance, usually over a long period of time*).

4.1.3.1 Wāhi tupuna, ara tawhito, and other archaeological features, and the project

Through the Statement, Kā Rūnaka strongly advocate for the completion of detailed archaeological investigations and assessments of the inundation zone and the surrounding areas which could be affected by the project. Those investigations should be completed prior to any activities which could result in further losses of those features and/or the values they hold for mana whenua. Given the remote location of the project area and the likelihood that further archaeology will be present, Kā Rūnaka seek that an archaeologist is present for any earthworks undertaken in areas identified as high value by the archaeological and heritage assessment.

4.1.4 Ecological values

Alongside the health of the wai, the responsibilities of Kā Rūnaka to protect and care for te taiao (*the natural environment*) is central to the status of mana whenua and the exercise of rakatirataka over their takiwā.

The habitats and ecology of indigenous freshwater and terrestrial species in the inundation area have already experienced cumulative adverse effects over time due to landscape modification and the introduction of exotic species such as brown trout and rabbits. Currently, a number of Nationally Threatened and At Risk native animals are known or suspected to be living in the environment surrounding Lake Onslow, including birds, fish and lizard species. Pāera/grey duck, and panapana/cress are Threatened species and are associated with the existing wetlands near Lake Onslow. The Teviot flathead galaxias fish, found in the tributaries to Te Awa Makarara/Teviot River, are a taoka species for Kāi Tahu. They have a Threatened-Nationally Critical conservation rating (the highest available), and face a severe risk of extinction should the population be exposed to predation. The pāera is a taoka in the Ngāi Tahu Claims Settlement Act 1998. The following species are also taoka in that legislation and are also understood to be associated with Lake Onslow and its surrounds:

- Kāmana crested grebe (Threated-Nationally Vulnerable)
- Kārearea New Zealand Falcon (Threatened-Nationally Vulnerable)
- Pihoihoi New Zealand pipit (At Risk-Declining)
- Koau black shag (At Risk-Declining)

The Mata-Au/Clutha River and its tributaries provide an important habitat for many native fish, bird and plant species. According to Schedule 1A of the Regional Plan: Water for Otago, the River is one of the most ecologically highly valued awa in Otago due to its size, variety of bed composition substrata and habitat characteristics.[10] Freshwater fish species records from the past four decades have identified the presence of a number of native freshwater fish species in the Mata-Au/Clutha River which are of value to Kāi Tahu as mahika kai or taoka species. Below Roxburgh, these include kanakana, tuna, īnaka and black flounder which are recognised as

[10] Aukaha (1997) Limited. (2022). *Cultural Values Statement*, page 43

mahika kai species.[11] Among other native species, Paraki/Ngaiore-common smelt *Retropinna retropinna*, Taiwharu-giant kokopu *Galaxias argenteus,* and Piripiripōhatu–torrentfish *Cheimarrichthys fosteri*, which are recognised as taoka fish species in Schedule 98 Part A of the Ngāi Tahu Claims Settlement Act 1998, were also recorded in this location.

In that context, Kā Rūnaka places great weight on efforts to protect native, taoka, and mahika kai species, not just as valued resources utilised by tūpuna in the past, but also as whanauka (*relatives*), connected to mana whenua by whakapapa to the atua.

4.1.4.1 Plant and algae biosecurity risk

Three well-known species of non-native pest algae or plant species are present in the Mata-Au/Clutha River:

- *Lagarosiphon major* (lagarosiphon)
- *Lindavia intermedia* (lindavia)
- *Didymosphenia geminanta* (didymo).

Lagarosiphon can displace and shade out aquatic native plants, and when it aggregates, it can disturb water flows, cause localised deoxygenation, have negative effects on aesthetic values and disturb freshwater recreation activities. Lindavia and didymo are types of brown algae which are capable of causing undesirable effects on the recreation and amenity values of the waterway. Emerging research suggests that didymo can also negative impact fish species both directly through alteration of habitat, and indirectly by bringing about changes to macroinvertebrate communities and consequently, food sources for fish.

These outcomes threaten the health of the water bodies and the native species (including those recognised as taoka or mahika kai) that rely on them for survival.

4.1.4.2 Ecological values and the project

Kā Rūnaka are clear that the construction and operation of the project should be undertaken in such a way as to protect threatened species, and restore, retain and where possible improve native habitats.

Particular concerns are raised by Kā Rūnaka in relation to the impact of the proposed activities on the Teviot flathead galaxias, which is currently protected from predation by trout, in the streams and tributaries around Lake Onslow. Without mitigation, mana whenua understand that the proposed inundation of Lake Onslow could lead to the extinction of this species. For mana whenua, it is vital that their survival is prioritised should the project proceed.

The transfer of water from the Mata-Au/Clutha River to Lake Onslow increases the possibility of transporting pest species into the Te Awa Makarara/Teviot River catchment. The spread of these unwanted species could negatively impact the mauri of these waterways, and as tangata taika/kaitiaki for the waterways in their rohe, Kā Rūnaka have a duty of care to protect waterways from biodiversity threats.

[11] NIWA Freshwater Database and Kuczynski, et al. (2022), referenced in Aukaha (1997) Limited. (2022). *Cultural Values Statement*, page 44

4.1.5 Equity values

The Cultural Values Statement discusses that throughout Aotearoa history post colonisation, a significant feature of the country's social and political landscape has been the lack of equity in outcomes, with the most acute and ongoing effects of that being experienced by Māori.

4.1.5.1 Equity values and the project

Given the potential wide-ranging benefits that could be available should the project proceed, mana whenua consider that it is vital for these benefits to be distributed equitably across the whole community, not just in employment, but through active engagement in all levels of the activity, including governance.

The Statement explains that since the gold rush days, many whanauka have taken advantage of employment opportunities within the region. Kā Rūnaka want to see those opportunities elevated, providing a platform for the development and growth of whanau through the acquisition of valued skills and experiences, and respecting and enabling the exercise of mana and rakatirataka (chiefly authority) within their takiwā as mana whenua.

4.2 Information gaps and risks to decision making

The Cultural Values Statement from Aukaha and the provisions regarding mana whenua values within the regulatory documents clearly outline the aspects of the environment within the project area that are of particular significance to Kā Rūnaka.

s 9(2)(g)(i) [redacted]

[redacted]

[redacted]

4.3 Recommended future actions

If the project progresses, it is recommended that:

- The project team continues to work with mana whenua, through Aukaha, in the design and operation of the project.
- A cultural impact assessment on behalf of mana whenua is commissioned once the design is sufficiently advanced and other studies have been carried out to identify where the most significant impacts of the project on cultural values are likely to occur, and what, if any opportunities exist for avoiding, remedying or mitigating those impacts, or providing offsets or compensation.

5 Freshwater

Freshwater is one of the fundamental environmental components of the proposed scheme given its reliance on water supply from the Mata-Au/Clutha River, the use of an enlarged Lake Onslow to store the water in the upper reservoir, the need to dam Te Awa Makarara/Teviot River; and the potential inundation of the Fortification Creek Wetland and other existing wetlands, streams and tributaries.

Freshwater is recognised as an important natural resource within Aotearoa New Zealand's legislative and planning framework with recent national planning documents (including the NPS-F and the National Environmental Standards for Freshwater (NES-F)) emphasising the fundamental importance of water and the need to protect its mauri or lifeforce through the concept of Te Mana o te Wai. In particular, these documents note the scale and extent of degradation within freshwater bodies across the country in the past and the resultant effects of that on the health of various eco-systems (including human health). This has prompted the imposition of a significantly more stringent freshwater regulatory regime. Further information about the detail of these documents is contained in **Chapter 18: Legislative Context**.

Within that context, this chapter describes the baseline characteristics of each of the main freshwater bodies that will be affected by the proposed scheme, namely:

- Lake Onslow
- The tributaries to Lake Onslow, including Te Awa Makarara/Teviot River
- The various wetlands within the project area
- The Mata-Au/Clutha River and Lake Roxburgh

This Chapter outlines the likely impacts that the project will have on each of these freshwater resources and describes identified gaps in the baseline understanding. Finally, consideration is given to the opportunities that might be available to mitigate, offset or compensate for the impacts of the proposed scheme on freshwater values.

To inform this work, MBIE has commissioned a range of reports from various technical specialists. Copies of those reports are included as in **Volume Two**.

A short summary of important concepts to aid in understanding the scientific information contained in these reports is included in Section 5.6 of this Chapter.

It is noted that some of the baseline values outlined in this chapter have implications for other values; for example, cultural values and recreation values, which are addressed in those chapters. It is also acknowledged that some species have lifecycles that occur both within freshwater and land (and may also utilise the marine environment). This Chapter should be read within that wider context.

5.1 Lake Onslow

Lake Onslow is located in an upland basin in wide open Otago tussock land about 700mASL to the east of Roxburgh. The catchment area of the existing Lake Onslow is 126km^2 and land within the catchment is used predominantly for grazing. The lake itself is human-made and was formed in 1891 by the damming of the Te Awa Makarara/Teviot River and Dismal Swamp. The water level of Lake Onslow has been raised four times by subsequent dams built for hydro-electricity generation in 1894, 1933, 1938 and 1982.

The current hydro electricity generation schemes are operated by Pioneer Energy Ltd via permits which require the 'impoundment' to be maintained at a minimum level of 679.9mASL, with a maximum rate of draw-down of 0.2m over any seven days, and the maintenance of a residual flow of at least 0.35m^3/s in the Te Awa Makarara/Teviot River. There are no other consented water takes in the wider catchment of Lake Onslow.[12]

It is noted that construction of the proposed project would result in the inundation of the existing Lake Onslow dam but would not impact on any of the downstream infrastructure that is operated by Pioneer Energy or Teviot Irrigation Company. The current residual flow of at least 0.35m^3/s into the Te Awa Makarara/Teviot River is expected to be maintained.

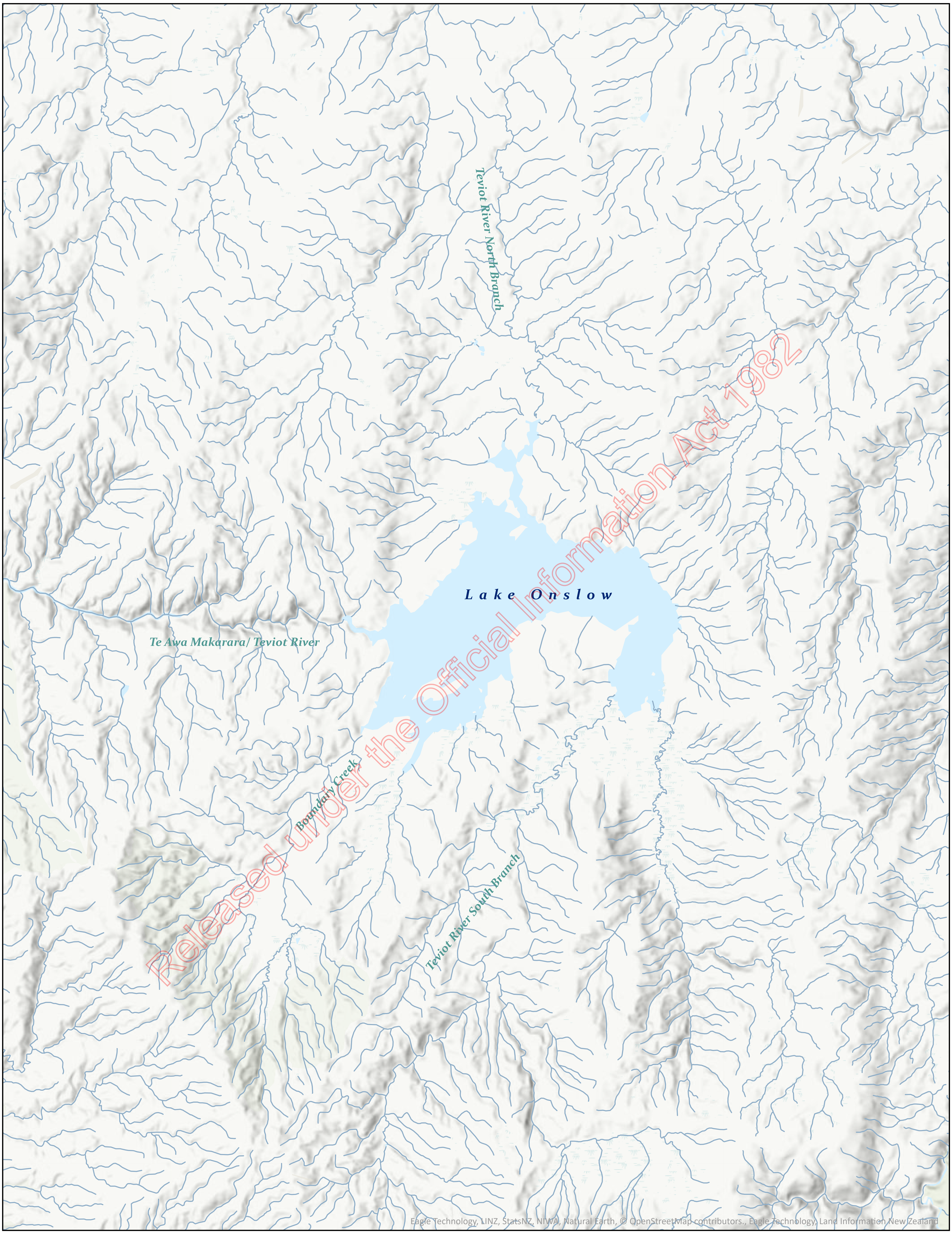
5.1.1 Baseline environmental characteristics: water

Lake Onslow is fed by a number of small tributaries within the catchment as illustrated in Figure 5.1, with the principal tributaries being:

- The upper Te Awa Makarara/Teviot River North Branch
- Boundary Creek
- Te Awa Makarara/Teviot River South Branch

The outflow from Lake Onslow is via the existing Onslow Dam, into Te Awa Makarara/Teviot River.

[12] Based on consents data mapped by Otago Regional Council at https://maps.orc.govt.nz/OtagoViewer/ accessed 8 August 2022



Paper Size ISO A3

0 0.5 1 1.5 2

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

TE RŌPŪ MATATAU
CONNECTED IN THINKING AND ACTION

Legend

Waterways

Ministry of Business, Innovation & Employment
NZ Battery Project: Lake Onslow Pumped Hydro Storage Option

5.1 Lake Onslow and its tributaries

U:\2021\BM210219_KGi_Project_Onslow\GIS\BM210219_EIS_template.aprx
Print date: 25 Aug 2022 - 14:33

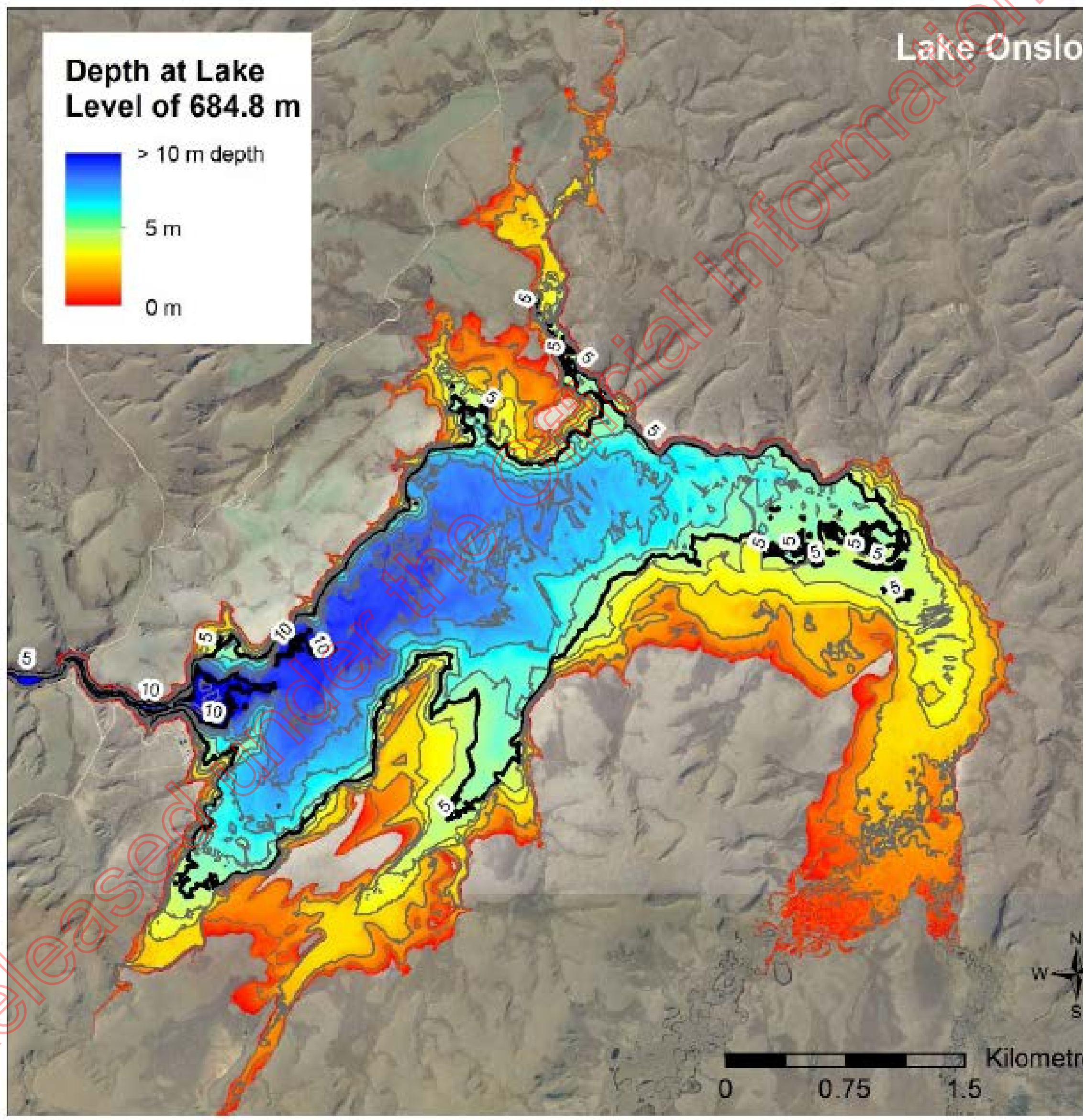
Data source: Rivers sourced from LINZ data service
Reviewed: DRo
Created by: scooter

5.1.1.1 Bathymetry

To better understand the bathymetry of Lake Onslow, NIWA undertook a bathymetry survey in May 2021. This data was complemented by LiDAR data of the land surrounding Lake Onslow. Figure 5.2 illustrates the findings of the bathymetry survey combined with the LiDAR data to illustrate the depths of the current lake. Together, these data assist with predicting the potential surface area and lake depth of the proposed upper reservoir.

As can be seen from the findings of the survey as illustrated in Figure 5.2, the deepest parts of the existing lake are generally within the channel just upstream of the existing dam, with a maximum depth of 12.8m.[13]

Figure 5.2: Lake Onslow bathymetry based on lake depth data collected during May 2021 and LiDAR data



Source: NIWA. (2022). Assessment of Lake Onslow climate, hydrology and ecology, Figure 3-2

[13] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology,* at page 54

5.1.1.2 Water levels

Water levels in Lake Onslow have been monitored by Pioneer Energy since 1974 as part of its operations management and consent requirements. The Lake was raised to its current level in 1982 and has an operating range of 6m (between 680mASL and 686mASL).[14]

The levels of the Lake vary from season to season and are generally at their highest in spring and lowest in winter. The Lake generally experiences the greatest drawdowns in summer. The median lake level fluctuation over the past 20 years has been approximately 2m per year, with a maximum fluctuation of 6m in 2004. High variation in annual flows generally occurs when drawdowns in summer are larger. [15]

5.1.1.3 Water quality

Water quality is one of the attributes that contributes to the ecosystem health of waterbodies and is a matter of high importance signalled in the NPS-F. Water quality is influenced by a range of characteristics, including the levels of dissolved oxygen, suspended material, and the levels of substances that signal nutrient enrichment of the water such as ammonia, nitrogen, phosphorous, and nitrates. In this regard, the NPS-F sets out a range of water quality attributes that are specifically relevant to lakes, namely:

- Total nitrogen (trophic state)
- Total phosphorus (trophic state)
- Ammonia (toxicity)
- Lake-bottom dissolved oxygen
- Mid-hypolimnetic dissolved oxygen

Otago Regional Council monitors water quality at Lake Onslow using data collected at the boat ramp to the western side of the lake, near the fishing huts. Surface water samples have been collected at mostly monthly intervals at this site since 2013. Between 2000 and 2013, samples were collected on a bi-monthly basis.[16] The Otago Regional Council data indicates that Lake Onslow is not experiencing severe water quality conditions such as phytoplankton blooms or dissolved oxygen 'sags' that could affect aquatic life. However, it is noted that this data only captures surface water quality.

NIWA and Cawthron undertook further water quality monitoring within the lake at a range of locations approximately quarterly during 2021 with a view to ascertaining whether the water quality of the lake in other locations and at different depths generally corresponded with the data recorded by Otago Regional Council. While limited in its timescale, this data represents a broader suite of locations and indicates *"that [the] water quality conditions throughout the mixed upper layer of the lake were excellent".* [17]

Figure 5.3 below illustrates the current water quality attributes of Lake Onslow as compared to the NPS-F bands and national bottom lines. This data indicates that primary production in the catchment is at a level where it is not severely impacting the water quality of the lake. [18]

---

[14] Cawthron. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 14

[15] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project,* at page 14

[16] Land Air Water Aotearoa, (2022). *Water quality*. www.lawa.org.nz accessed 7 August 2022

[17] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 16

[18] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 16

Figure 5.3: Water quality – Lake Onslow

Attribute	Lake Onslow existing data
Total Nitrogen (lakes)	
A	Lake Onslow in A band (Cawthron)
B	
C	
NBL	
D	
Total phosphorous (lakes)	
A	
B	
C	Lake Onslow in C band (Cawthron)
NBL	
D	
Ammonia (rivers and lakes)	
A	Lake Onslow in A band (ORC)
B	
NBL	
C	
D	
Lake-bottom dissolved oxygen (lakes)	
A	Lake Onslow in A band (NIWA)
B	
C	
NBL	
D	
Mid-hypolimnetic dissolved oxygen (lakes)	
A	Lake Onslow in A band (NIWA)
B	
C	
NBL	
D	

Source: Te Rōpū Matatau, adapted from NIWA. (2022). Assessment of Lake Onslow Climate, Hydrology and Ecology; Cawthron Institute. (2022). Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project; and www.lawa.org.nz

5.1.1.4 Water clarity

Visual clarity data indicates moderate levels of turbidity, with visual clarity ranging between 1.5m and 3.1m. This is likely affected by both suspended sediments and 'humic staining' as a result of relatively high concentrations of dissolved organic matter introduced to the Lake from the surrounding tussock peatland.[19]

5.1.1.5 Residence time

Hydraulic residence time can be used to estimate phosphorus and nitrogen retention coefficients in a water body[20] as a measure of water health. It also influences the extent to which suspended solids in the water body can settle, which in turn can influence water clarity. The time that it takes for suspended solids to settle is dependent not only on the residence time of the water body, but also the type of suspended solid; the depth of the water body; and the exposure to wind.

NIWA has estimated the residence time of Lake Onslow to be approximately 219 days (or 0.6 year). [21] Suspended sediments in Lake Onslow currently take a little over one day to settle to the bottom of the lake, based on the assumption that particles are dominated by silt (not biogenic).[22] If particles are actually dominated by phytoplankton (biogenic), settling times may be longer than these estimates.[23]

5.1.1.6 Water temperature

Water temperature is the dominant influence on density in freshwater systems, which determines whether the water column is stratified or well mixed. Cooler water is generally denser and thus will 'sink', whereas warm water is less dense and will rise to the surface. Notwithstanding this general principle, water is most dense at 4°C, and then becomes less dense at temperatures below 4°C. Stratification of the water column into layers can lead to a reduction in dissolved oxygen levels, which can be detrimental to fish health and the health of other biota. Stratification is explained in Section 5.6 of this Chapter.

NIWA measured water temperature in Lake Onslow using conductivity-temperature-depth (CTD) profilers at six locations on three occasions: 31 March 2021, 6 May 2021 and 7 December 2021. The results are summarised in Table 5.1**.** Temperature data is also available from the monitoring buoy that NIWA installed in the Lake, but only for the period 27 September-3 November 2021.

The NIWA data indicates that the thermocline (the point of greatest temperature difference in a stratified lake) ranges between a depth of 1m and 9m below the surface of the Lake but is typically at a depth of 5m.[24]

[19] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project, at* page 65

[20] Retention coefficients are the fractions of nutrients that enter a lake which are retained in the lake and either assimilated by primary producers (e.g. aquatic plants and algae); consumed by consumers (e.g. invertebrates or fish); or adsorbed to sediment and possibly buried

[21] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology*, at page 37

[22] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology*, at page 54

[23] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology*, at page 59

[24] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology,* at page 49

Table 5.1: Water temperature readings in Lake Onslow during March, May and December 2021

	31 March 2021	6 May 2021	7 December 2021
Water temperature	~13.7°	~7.3°	~14° - ~18°
Mixing state	Nearly mixed	Well mixed	Stratified

Source: Te Rōpū Matatau, data sourced from NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology*, at page 47

5.1.1.7 Stratification

To better determine the extent to which the Lake is stratified or well mixed, NIWA also measured hydrodynamic conditions using data collected from a monitoring buoy installed in the Lake. Measurements between October 2021 and March 2022 show that Lake Onslow stratifies for short periods of time (less than 10 days) before wind mixes the water column, with wind speeds of 7.5m/s appearing to be sufficient to remix the water column. The maximum period of stratification observed was 10 days,[25] and 10 significant periods of stratification were observed. The short duration of this existing stratification indicates that adverse impacts on fish health are not occurring.[26]

5.1.1.8 Dissolved Oxygen

NIWA also measured the levels of dissolved oxygen in the Lake at 1m below the surface, and at 1m above the bed of the Lake as fish health can be adversely affected when dissolved oxygen levels are less than 5mg/L.[27] The NIWA data indicates that dissolved oxygen levels did not drop to levels of ecological concern during the period that NIWA was monitoring data in the Lake.[28]

5.1.1.9 Lake Onslow trophic state

The trophic state of a lake refers to its nutrient status and levels of phytoplankton biomass. The trophic level index (TLI) score is commonly used in New Zealand to describe the levels of nutrients in a lake and its impacts. TLI scores are based on measurements of four parameters: water clarity, chlorophyll content, total phosphorous and total nitrogen. TLI scores are normally calculated as an annual average from monthly samples.

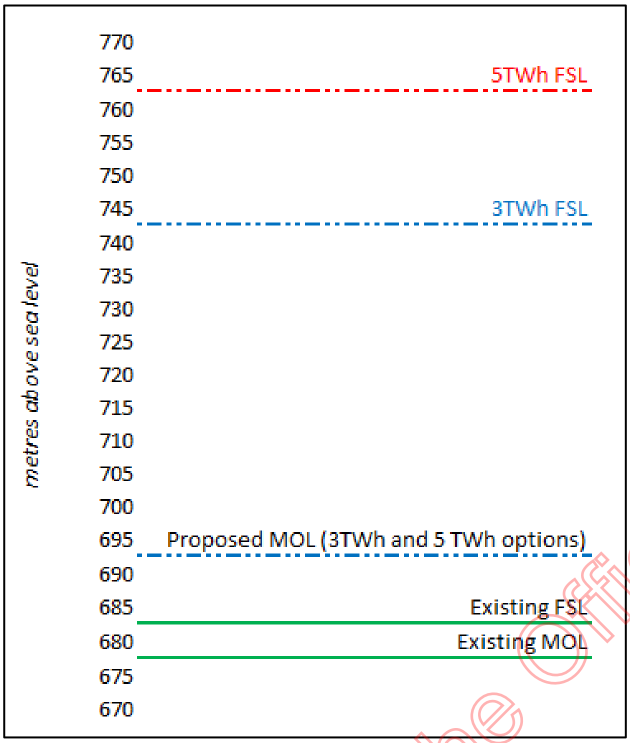
NIWA surveyed Lake Onslow from several locations in the Lake on a single occasion in March 2021. These preliminary results from a single sampling occasion indicate that Lake Onslow is currently mesotrophic.[29] This means it has an intermediate level of productivity. Otago Regional Council also collects data on the trophic state of Lake Onslow on a monthly basis (when access allows) from a single location near the existing boat ramp. While this data set is a surface sample (and therefore may not represent the whole lake) it also indicates that the Lake is currently mesotrophic.[30]

[25] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology,* at page 49
[26] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology*, at page 11
[27] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology*, at page 49
[28] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology*, at page 43
[29] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology,* at page 11
[30] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 21-22

5.1.2 Potential impacts of the project on baseline characteristics: water

The principal impacts of the proposed scheme on the water levels of Lake Onslow will be the creation of a significantly larger reservoir in the Lake Onslow basin, and the introduction of a large volume of water to the area from a new water source – the Mata-Au/Clutha River. As shown in Figure 5.4 below, the new water levels will be significantly higher than the current levels.

Figure 5.4: Existing and potential future lake levels - Lake Onslow



Source: Te Rōpū Matatau

FSL: Full supply level; MOL: Minimum operating level

In terms of water quality, it is noted that, relatively speaking, the levels of dissolved inorganic nitrogen in the Mata-Au/Clutha River (as the proposed water source for the upper reservoir) are higher than those in Lake Onslow and its tributaries, but still at a low level for lakes, and well below the A-band nitrate toxicity threshold in the NPS-F. As such, it is expected that the potential increases in primary productivity (amount of algae produced) within Lake Onslow arising from the pumping of water from the Mata-Au/Clutha River into the lake would likely be small.[31]

NIWA developed a one-dimensional hydrodynamic model of Lake Onslow to simulate current lake level changes, the extent of mixing within the water column, and stratification. This model was then used to assess the potential impact of different operating scenarios on the Lake over a 10-year period. At the time NIWA commenced this modelling in August 2021, a decision on how the proposed scheme might be operated had not been made, and nor had a decision been made on the future lake level(s), so NIWA developed some potential operating scenarios to run through the model. A summary of these operating scenarios is set out in Table 5.2.

[31] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 37

Table 5.2: Overview of operating scenarios modelled by NIWA

Characteristic	Dry year operating scenario		Daily peak buffering scenario	
Overall description	Lake Onslow used to generate a large amount of power over a period of three months in a dry year. Dry year assumed to occur once every five years.		Lake Onslow used to cover daily peaks in power demand, producing power for a few hours each day and then being refilled during off-peak times.	
Lake levels and operating range	740m	780m	740m	780m
	~36m	~31m	0.025m-0.101m per day	0.018m-0.072m per day
Outflow rates	206m³/s	289m³/s	50m³/s	200m³/s
Inflow and outflow level	Single level at 685m			
Time taken to fill the lake	Three years Filling occurs between December and January in each of the Three years		14-hour period each day	
Drawdown period	Continuously from May-July		Eight-hour period each day	
Water source	Lake Roxburgh			

Source: Te Rōpū Matatau

In May 2022, a description of the project that reflected the design work that had been undertaken to that point was provided to NIWA (and other technical specialists who had been providing MBIE with baseline environmental information) in order to seek feedback on any changes to their original findings that might arise from the emergent details about the project.

Some of the key differences between the original scenarios that NIWA modelled and the subsequent details about the project provided in July 2022 are:

- The revised maximum lake operating levels proposed were in the range of those considered by NIWA (745mRL and 765mRL compared to 740mRL and 780mRL)
- Lower minimum lake operating levels were proposed, so there was a greater draw-down potential than those originally modelled by NIWA
- NIWA originally assumed inflows and outflows at a level of 685m, but the advanced design proposes a multilevel intake
- Differences in the timing and rate of discharge to and from the Lake
- The potential for offtakes to be located at s 9(2)(i) [redacted]
- The potential for a new lower reservoir at the s 9(2)(i) [redacted] offtake locations.

An overview of NIWA's original findings about the potential stratification of the Lake using its preliminary scenarios; and advice received subsequent to NIWA considering the Project Description is set out in the following paragraphs.

Using its hydrodynamic model of Lake Onslow, NIWA used the operating scenarios that it developed in December 2021 to predict potential stratification outcomes at Lake Onslow. This indicates that increasing the level of the lake by pumping water from the Mata-Au/Clutha River will result in significantly longer periods of stratification for the deeper lake scenarios. The model predicts that under the original operating scenarios that NIWA modelled, Lake Onslow is likely to become monomictic (mixing once per year) with a long period of summer stratification, although this will depend on the refill water temperature and the ultimate lake level.[32]

Having considered the additional information provided about the potential lake levels and drawdown potential, NIWA advised that the proposed maximum lake levels suggest that stratification events in a future Lake Onslow will have durations and vertical extents within the range identified in NIWA's initial modelling described above.[33]

As set out previously, increased periods of stratification can be expected to increase the risk of the lake becoming hypoxic in some layers (levels of dissolved oxygen are too low to support life) although this will ultimately depend on the rate of deoxygenation in the lower level of water in the stratified lake, which is not easily predicted. Deoxygenation occurs as organic material within the Lake decomposes and, in this regard, it is noted that the sediment oxygen demand is likely to be at its highest during and after the initial years of lake filling as recently submerged organic matter decomposes. It is for this reason that reductions in dissolved oxygen are common in newly formed reservoirs and lakes, such as at Lake Opuha.[34]

In addition to the above, there is a moderate risk that inundation of extensive areas of tussock peatland and farmland during the creation of the proposed upper reservoir could result in significant nutrient and dissolved organic compound influx, along with oxygen demand from flooded soils and tussock peatland vegetation. This process also has the potential to reduce the water quality in the proposed upper reservoir. [35]

With respect to water clarity, NIWA has undertaken a pilot study to assess the extent to which fine sediments pumped up into Lake Onslow from either Lake Roxburgh or the Mata-Au/Clutha River (at Millers Flat) could affect the water quality at Lake Onslow. NIWA has also undertaken work to assess the depth that light is likely to be able to reach, as this directly affects the temperature of the water column. Preliminary results from that analysis indicate that light conditions in a future Lake Onslow may resemble those of the water source (Lake Roxburgh or Mata-Au/Clutha River) if the pumped inflows make up 80-95% of the total inflows.[36]

If water is taken from Lake Roxburgh to create the upper reservoir, the limited field data available to date indicates that water clarity in Lake Onslow could be improved. However, this could be negated by the effects of erosion of the banks of the Lake from changing water levels which will result in large, exposed beds of sediment and loose detritus. This will be easily eroded into the Lake by rain and wave action, exacerbated by wind fetch across the larger expanse of the Lake. During summer, wind can blow dust from the exposed lakebed, with some entering the Lake. This erosion would lead to increased turbidity and suspended sediment in the lake, affecting water clarity, macroinvertebrate habitats and feeding rates.[37]

Overall, the project will result in a much larger water body with greater levels of fluctuation in the water levels. There is the potential for the Lake to stratify for much longer periods of time; however, this will depend on a range of factors that require further modelling.

5.1.3 Options to address impacts

NIWA's modelling was based on inflows and outflows to/from the Lake at a single level (685mASL). However, the proposed multi-level intake provides greater ability to control mixing

32 NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology,* at page 12

33 NIWA. (2022). *Addendum to Lake Onslow baseline reports,* at page 10

34 NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology,* at page 13

35 Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 71

36 NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology,* at page 57

37 NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology,* at page 11

and stratification by choosing the depth at which water is introduced to, or withdrawn from, the Lake.[38] Operation of the project should be guided by in-lake monitoring of temperature, oxygen, and water quality conditions (nutrient concentrations and phytoplankton) as this will be important to inform which intake level to use, as well as the level at which water is best discharged into the Lake so as to manage water quality and stratification. [39]

Work undertaken by Wildlands suggests that in order to reduce the amount of organic biomass that will decompose underwater, quality terrestrial vegetation could be removed by Vegetation Direct Transfer and used to rehabilitate other areas. Rehabilitation zones could include retired farmland above the high-water line, lake and stream margins, and wetlands, both within the Lake Onslow catchment or at off-site mitigation sites.

A very preliminary suggestion has been made to remove all soil from the inundation area and strip the area to schist bedrock.[40] While this measure would completely remove the risk of soil erosion into the Lake, as well as the water quality and greenhouse gas effects arising from the inundation of soils and vegetation, such a measure is extremely ambitious, and its feasibility has not been assessed. It is also noted that large parts of the Lake Onslow basin are not underlaid by schist, but instead are infilled with quaternary clays and gravels down to 40m depth in places. In addition, such a measure could have significant unintended consequences on the wider ecosystem such as changing the basis of the food web of the Lake, and the species that form part of that food web. Newly exposed schist rock could change the water quality of the Lake due to the leaching of chemicals from a large area of rock. There would also be inherent challenges associated with the containment, removal and disposal of the soil. [41]

5.1.4 Baseline characteristics: aquatic ecology

Lake Onslow currently provides habitat to a range of plants, invertebrates, birds and fish, as detailed in this Chapter and in **Chapter 7: Indigenous Biodiversity**. Ecologically, the terrestrial margins of a lake are highly productive, providing important cover and nesting habitat for birds, habitat for invertebrates (which, in turn, are an important food for many animals), and filtering sediment from surface runoff. [42] Lake margins can provide a very important source of organic detritus into the Lake, but NIWA has advised that the sources of littoral zone detritus in the Lake are presently unknown.[43]

From a conservation values/ecological perspective, Lake Onslow is considered to be of regional ecological significance.[44]

5.1.4.1 Aquatic plants

The extent and nature of aquatic plants in a water body can be an indicator of its ecosystem health. Reflecting this, the NPS-F includes attributes that relate to phytoplankton (in milligrams of chlorophyll-a per square metre) and submerged plants (native and invasive) based on the

[38] NIWA. (2022). *Addendum to Lake Onslow baseline reports,* at page 10
[39] NIWA. (2022). *Addendum to Lake Onslow baseline reports,* at page 11
[40] Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme,* at page 56
[41] Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme,* at page 56
[42] Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme,* at page 55
[43] NIWA. (2022). *Habitats Supporting Fish Production in Lake Onslow,* at page 20
[44] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*

Lake Submerged Plant (Native Condition Index) and the Lake Submerged Plant (Invasive Impact Index). National bottom lines are set in relation to all three of these attributes.

Based on the 10-year median concentration of data available, the level of phytoplankton biomass in the lake would put Lake Onslow in the B band under the NPS-F for this attribute. [45] Within the NPS-F this means that the "*lake ecological communities are slightly impacted by additional algal and/or plant growth arising from nutrient levels that are elevated above natural reference conditions*".

Given the invasive *Lindavia intermedia* (lake snow) is already widespread in the lakes in the Upper Clutha catchment, Cawthron undertook specific monitoring for its presence but did not identify it in Lake Onslow.

The current macrophyte community in Lake Onslow is dominated by turf species, which are predominantly native. These plants are well adapted to the existing water level fluctuations that uncover extensive portions of the shoreline and may also have adapted to being exposed during winter and potentially frozen.[46]

Only one invasive species was identified within the Lake, and was generally found at low density (*Juncus bulbosa)*. [47]

There is one data point for Lake Submerged Plant information from November 2020. This indicates the Native Condition Index was 53%, which would put Lake Onslow into the B-band for this attribute in the NPS-F meaning "*high ecological condition. Native submerged plant communities are largely intact*".

The Invasive Impact Index was 17.3%, which similarly would put Lake Onslow into the B-band for this attribute indicating "*invasive plants have only a minor impact on native vegetation. Invasive plants will be patchy in nature co-existing with native vegetation. Often major weed species not present or in early stages of invasion*".[48]

5.1.4.2 Aquatic animals

Cawthron identified the presence of 12 taxa of zooplankton during monitoring undertaken in 2021. Most of the taxa identified were small bodied and are therefore likely to represent lower value prey items to fish.

Historical investigations into the presence of macroinvertebrates within the Lake in the 1990s found 34 taxa, and a relatively high mean density of invertebrates (29,650 animals per square metre). The most dominant taxa collected were worms and bloodworm larvae of the midge *Chironomus*. Both are sediment dwellers that feed on organic material. Ongoing survey work by Pioneer Energy in 2016 and 2017 indicates stable populations with some taxa increasing and others decreasing, largely related to the composition of the substrate.[49] No field work was undertaken by Cawthron to sample the macroinvertebrate populations within the Lake.

Freshwater crayfish/kōura (including at least one At Risk-Declining species) are known to be present in several waterways in the northern catchments of the Lake Onslow area and may be

[45] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 20

[46] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 41

[47] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 40

[48] NIWA. (2022). Lake Onslow Submerged Plant Indicators. https://lakespi.niwa.co.nz/lake/1553 accessed 7 August 2022

[49] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 66-67

present elsewhere in the catchment area.[50] Historical survey records indicate that Lake Onslow appears to contain the highest densities of kōura in the Te Awa Makarara/Teviot River catchment.[51] NIWA divers detected kōura in the Lake during surveys of Lake Onslow and other lakes in the Otago region in 2020.[52] Surveys conducted by Cawthron in 2021 did not find any kōura in Lake Onslow, which could indicate a decline since earlier surveys, but could also be a result of the differences in the survey methodology between studies.[53]

Cawthron and DOC have both undertaken baseline investigations to better understand the fish species that live within the inundation area and parts of the wider study area. NIWA has undertaken analysis of the food sources supporting the trout population in Lake Onslow. The work undertaken by NIWA sought to determine the food source for brown trout within the current Lake Onslow. Potential food sources are within the littoral zone of the Lake, or in the open water areas. Field survey work was undertaken during winter-spring 2022 and the findings showed that most of the energy supporting trout during this period was from common bullies (55%) and *Chironomus* larvae (40%). Common bullies source over 90% of their energy from *Chironomus* larvae. *Chironomus* larvae inhabit the littoral zone of the lake.

The Otago Fish & Game Council has also undertaken an investigation into the effects of an enlarged Lake Onslow on the availability of trout spawning habitat. Further details of the findings of Fish & Game's investigation are set out in Sections 5.2.1 and 5.2.2 of this Chapter.

Field surveys undertaken in 2021 detected two species of fish in Lake Onslow: common bully and brown trout.[54] Brown trout are the only sports fish present in the Lake, and exist in abundance.[55] There appears to be a lack of either longfin eels or other species such as kōaro that might normally inhabit inland lakes.[56] There was no evidence of non-migratory galaxiid species being found in the Lake, despite being present in some of the upstream tributaries. [57] Downstream dams on the Te Awa Makarara/Teviot River clearly inhibit upstream fish migration and have greatly limited the fish species found in Lake Onslow. [58]

5.1.5 Potential impacts of the project on baseline characteristics: aquatic ecology

Although the magnitude of effect will depend on the ultimate operating regime chosen, the large variation in lake levels associated with the proposed upper reservoir will likely have a major negative effect on benthic communities such as macrophytes and invertebrates.[59]

Specifically, initial inundation of Lake Onslow may change water levels by up to 75m from exisiting, with a maximum operational drawdown of 50m. This ecosystem previously had water

---

[50] Wildlands Consultants Limited. (2022). *Evaluation of Freshwater Invertebrate Features and Values at Lake Onslow, Central Otago*, at page 12

[51] Department of Conservation. (2022). *Survey Report – Freshwater Fish Values (NZ Battery Project - Lake Onslow Option), at* page 16

[52] NIWA. (2021). *Assessment of Six Lakes in the Otago Region using LakeSPI,* at page 23

[53] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project,* at page 62

[54] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 58

[55] Otago Fish & Game Council. (2022). *An Investigation into Lake Onslow Brown Trout Spawning Habitat Availability at Increased Lake Heights*, at page 2

[56] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page iii

[57] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project,* at page ii

[58] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 67

[59] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 70

level fluctuations averaging two metres annually. As a result of this change, it is expected that there will be severe effects on macrophyte and periphyton communities, and probably a total loss of macrophytes within the lake.[60]

The water level fluctuation (WLF) associated with the operating regime of the proposed scheme will also affect the lake shore of the enlarged lake and the littoral zone. The WLF factors that determine these effects include:

- Amplitude
- Timing
- Frequency
- Rate and level changes

Using an enlarged Lake Onslow as the upper reservoir of the proposed scheme has the potential to result in erosion of the littoral zone, which in turn can affect the composition and abundance of biological communities in the Lake such as plants and fish. Benthic algae are relatively resilient to WLF, but macrophyte communities would be predominantly affected. Effects on macrophyte communities would have flow on effects to other species in the foodweb (e.g. brown trout).

New aquatic plant communities would not be likely to establish until the new lake is filled, which could take a number of years. As the lake levels rise above 700m, the lack of light will mean that original vegetation in the existing lake will begin to die and decompose. As the lake continues to expand, it will submerge existing terrestrial soils and vegetation, which will lead to the decomposition of the inundated vegetation.

The decomposition of submerged vegetation results in decreasing concentrations of dissolved oxygen and a release of nutrients in the water column of the lake. Greenhouse gas emissions can also arise from the decomposition of submerged organic matter. Further details on this matter are addressed in **Chapter 15: Greenhouse gas.**

It is considered unlikely that the submerged plant species present in Lake Onslow would be able to survive with the much larger water level fluctuations that would occur in the proposed upper reservoir and as a result it can be expected that submerged plant species would almost entirely disappear from the lake.[61]

Aquatic turf plant communities that thrive in more extensive wetting/drying cycles are spatially dominant around the margins of the Lake. These communities may be able to endure a larger reservoir with more extensive water level fluctuations. While further details about the potential operating regime are required to better understand the likelihood of this occurring, there would likely be a significant change in the lake-edge plant communities of Lake Onslow.[62]

There is a low risk of didymo becoming a problem in the proposed upper reservoir because the physical habitat of the Lake is unsuitable for this species. Didymo is generally restricted to hard-bottomed habitats with constant water movement, and it does not tolerate being dried out. There is the potential for *Lindavia intermedia* (lake snow) to be introduced into the Lake. NIWA has advised that the extent to which the future reservoir would become susceptible to nuisance growth of *Lindavia intermedia* depends on the water chemistry and quality in the reservoir.

[60] Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme,* at page 64

[61] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 41

[62] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 41

There is the potential for various aquatic weed species such as *Lagarosiphon major* and *Elodea canadensis* to be introduced to Lake Onslow through the pumping of water up into the proposed reservoir from either Lake Roxburgh or the Mata-Au/Clutha River. Both of these weed species can have significant effects on macrophyte communities, lake ecology, and food webs.

If fragments of these plant species are transferred through the proposed waterway into Lake Onslow, the extent to which they will survive the transfer process depends on whether they can withstand the water pressures in the tunnel. While there is some evidence to suggest that fish can withstand simulated pumping pressures of 75atm[63] and 50atm,[64] there is no such equivalent information on plants exposed to similar pressure. NIWA anticipates that the transfer of aquatic weed species through the waterway tunnels would degas the air spaces in the tissues of the plant fragments, which could contribute to reduced survival of these fragments because they would no longer float to the surface of the water and would die. However, further work is required to better understand this potential, and NIWA cannot rule out the survival of vegetative fragments of vascular plants when transported under the anticipated pumping pressure.[65]

Cawthron advises that both *Lagarosiphon major* and *Elodea canadensis* are sensitive to large water level fluctuations, so if this is a characteristic of the proposed operating regime it is unlikely that either of these species would establish to any significant extent,[66] even if fragments did survive the water transfer process. NIWA has advised that it is unlikely that macrophytes (including pest plants) would establish unless water level fluctuations in the proposed upper reservoir are <5m and water levels are held for periods greater than 6-12 months.[67]

As noted above, the primary food sources for brown trout in the Lake (based on preliminary findings) are currently found in the littoral zone of the Lake. Declines in the littoral zone habitat may necessitate fish to seek food sources in the open water zones of the Lake, noting that food sources in this part of the Lake are unlikely to contribute any more energy than they currently do.

An increase in the water level fluctuations associated with an enlarged Lake Onslow would decrease the richness of macroinvertebrate communities in the littoral zone of the Lake. The drawdown rate will inform the extent to which macroinvertebrates can relocate, and there is the risk that they could be stranded if the drawdown rate is swift. The loss of macrophytes due to water level fluctuation also reduces shelter to macroinvertebrates, thereby exposing them to greater levels of predation. [68]

Stratification periods extending beyond two weeks may make deeper parts of the Lake uninhabitable for trout until the lake remixes due to low levels of dissolved oxygen being available. Trout may survive by avoiding deeper parts of the Lake during such times.[69]

Changes to the water levels of Lake Onslow during the operation of the scheme also have the potential to adversely affect the food supply for brown trout.

Short-term effects on the trout food supply associated with the initial filling of the upper reservoir will depend largely on the degree to which dissolved oxygen is available to the benthic communities that provide food sources to trout. If dissolved oxygen levels are depleted, then the

[63] A standard atmosphere unit

[64] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology,* at page 107

[65] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology,* at page 107

[66] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 41

[67] NIWA. (2022). *Addendum to Lake Onslow baseline reports,* at page 12

[68] NIWA. (2022). *Addendum to Lake Onslow baseline reports*, at page 12

[69] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology*, at page 43

food source available to trout will likely decrease, and affect their population size. If dissolved oxygen levels remain available to benthic consumers, an increase in the volume of detritus at the base of the food web may temporarily increase production of brown trout.[70]

The ongoing effect of the proposed water level fluctuations in the upper reservoir on the food available for brown trout will depend on the extent to which these fluctuations affect the littoral zones of the Lake. Negative impacts on the littoral zone will exacerbate adverse impacts on trout populations due to reduced food supply.

It is important to note that seasonal variations to the energy source for trout have not yet been determined. Anecdotal evidence indicates that terrestrial food sources (e.g. insects) comprise a large proportion of trout diet during summer-autumn,[71] and further work would be required to ascertain this. [72]

As a result of pumping water into the Lake, different fish species may be introduced accidentally. Whether these species are exotic or indigenous, they may cause significant changes to the ecosystem and cause competition for resources or food within the Lake or its tributaries. The incidental introduction of different fish species may have a high level of effect. The species of greatest concern is kōaro (*Galaxias brevipinnis*, At Risk-Declining), which readily establishes in lakes and easily out-competes and consumes dusky galaxias (*Galaxias pullus*, Threatened-Nationally Endangered).

Additional modelling work is required to better understand the risk associated with increased levels of nutrients in the enlarged lake.

5.1.6 Options to address impacts

Due to the fluctuating water and light levels in the lake, any mitigation within Lake Onslow to protect macrophyte and periphyton communities is considered unlikely to succeed. Wildlands therefore recommend that to offset this effect, macrophyte and periphyton communities in similar nearby lakes could be enhanced, and if necessary, macrophyte species could be translocated to nearby lakes before inundation. A comparison of the macrophyte composition in other local waterbodies against the macrophyte composition in Lake Onslow would be beneficial to determine the extent to which species in Lake Onslow are already present in those waterbodies, and whether habitats in those waterbodies would be suitable to receive any translocated species from Lake Onslow.

As has been outlined in Section 5.1.5 above, there is the potential for aquatic pest plant species to be introduced to Lake Onslow. The extent to which these plant fragments would survive the pumping process is uncertain, but there is the possibility that the plant fragments would be de-gassed due to the pressure in the tunnels, and would therefore sink to the bottom of the Lake upon discharge. Due to the likely lack of light at those depths, these plants would likely not survive. Further work is required to understand the potential for this effect to occur. In addition, it is unlikely that plants will establish in a future Lake Onslow unless the water level fluctuations are less than 5m and this water level is held stable in the lake for at least 6-12 months. There is further potential to minimise the chance of weed establishment within the Lake by discharging water via the multi-level inlet at depths of 10m or more.

Wildlands has proposed the use of screening at the intakes into the pumping system and at the Lake Onslow outfall to assist with preventing weed fragments from being pumped into the Lake. In addition to the work required to better understand the *likelihood* of pest plants surviving the pumping process, and the extent to which any surviving fragments would survive in the water

[70] NIWA. (2022). *Habitats Supporting Fish Production in Lake Onslow,* at page 21
[71] NIWA. (2022). *Habitats Supporting Fish Production in Lake Onslow,* at page 5
[72] NIWA. (2022). *Habitats Supporting Fish Production in Lake Onslow,* at page 23

quality and light conditions of the future lake, a review of the hydraulic implications of any such screening would need to be undertaken to determine if this recommendation is feasible.[73] *Lagarosiphon major*, for example, is capable of regenerating from fragments with a mean length of just 32mm.[74]

Noting that fish screening structures are already proposed at the offtakes at s 9(2)(i) [redacted], Wildlands has noted that fish screens at intake locations would need to be fine enough to prevent fish larvae to be entrained into the proposed scheme, or to sterilise the pumped water. There is a range of nuances associated with determining the most appropriate fish screen design, and this depends on the type of water body (flowing or still); the fish species present and their characteristics and preferences; and the impacts of fish screening on the overall hydraulics of the scheme. While preliminary discussions have been had with NIWA on this matter, ongoing discussions will be required with regulators such as Otago Regional Council, and other stakeholders such as Aukaha and Fish & Game in order to determine the ultimate fish screening requirements. The feasibility of the options suggested by Wildlands can be factored into that ongoing process.

Wildlands has considered various mitigation options with respect to the impact on the brown trout fishery, including artificial spawning channels, creating new spawning habitat, stocking the lake with hatchery fish, and imposing local fishing regulations to ease pressure on the trout population. However, Wildlands considers these measures to "*be of limited benefit and would clash with indigenous ecological values*".[75] As such, Wildlands recommends enhancement of other trout fisheries in the Otago Region to offset the loss.

Advice from Wildlands on potential mitigation options identifies Butchers Dam, Moke Lake and Lake Johnson in the Mata-Au/Clutha River catchment as recreational fisheries that may be suitable for enhancement sites as mitigation for Lake Onslow as there are no non-migratory galaxiid populations at risk if these lakes were to have increased trout numbers. Further investigation into the appropriateness of these locations would be required.[76]

Actions at alternative locations could include increasing or improving spawning and/or rearing habitat for trout, improving habitat for food species (both terrestrial and aquatic), and the food required by food species, and angler education on best practice methods for catch and release to ensure trout survival. [77]

5.2 Tributaries of Lake Onslow (including Te Awa Makarara/Teviot River)

As illustrated in Figure 5.1 above, the principal tributaries of Lake Onslow are:

- Te Awa Makarara/Teviot River and its tributaries, comprising the following:
  - The main stem of Te Awa Makarara/Teviot River, which flows west out of Lake Onslow from the existing dam, connecting the Lake to the Mata-Au/Clutha River.
  - Upper Te Awa Makarara/Teviot River North Branch, which flows into Lake Onslow from the north.

[73] Noting that fish screens are included in the proposal description currently, but they are for the purpose of fish passage

[74] Redekop, P., Hofstra, D., Hussner, A. (2016). *Elodea canadensis shows a higher dispersal capacity via fragmentation than Egeria densa and Lagarosiphon major*. Aquatic Botany, 130:45–49

[75] Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme,* at page 62

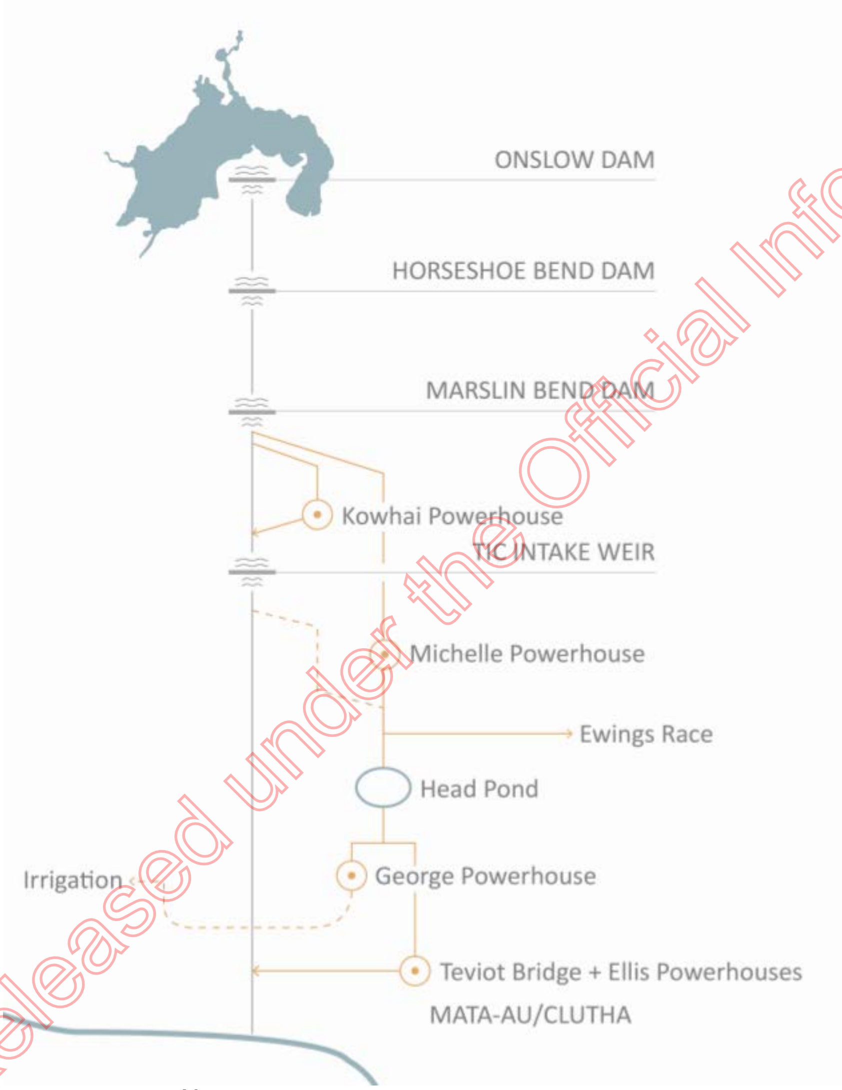
[76] Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme,* at page 63

[77] Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme,* at page 62

  - Te Awa Makarara/Teviot River South Branch, and its major tributaries, Armstrong's Creek and the Te Awa Makarara/Teviot River South Branch Upper. Te Awa Makarara/Teviot River South Branch flows into Lake Onslow from the south.
- Boundary Creek, which flows into Lake Onslow from the south.

The main stem of Te Awa Makarara/Teviot River currently supports a combined hydro power scheme and an irrigation scheme (operated jointly by Pioneer Energy and the Teviot Irrigation Company). The scheme comprises a series of on-river and off-river components, including four dams and five powerhouses located along the primary branch of the River, with a combined generating capacity of 16.5MW (illustrated in Figure 5.5). Publicly available GIS data shows that there are no other consented takes downstream of the existing Onslow Dam.[78]

Figure 5.5: Schematic of the Pioneer Energy and Teviot Irrigation Company (TIC) hydro infrastructure on the Te Awa Makarara / Teviot River



Source: Te Rōpū Matatau

[78] Otago Regional Council. (2022). Maps. www.maps.orc.govt.nz/Otagoviewer search on 8 July 2022

As set out further below, enlargement of Lake Onslow as part of the project would, to varying extents, result in the inundation of the Lake's tributaries, including Te Awa Makarara/Teviot River.

In order to inundate the Lake, a proposed dam would be constructed downstream of the existing dam, resulting in its inundation. The dam construction will also require the Te Awa Makarara/Teviot River to be diverted from its current riverbed for a significant part of the dam's construction period (between four to five years). Once the dam is completed, downstream releases to the Te Awa Makarara/Teviot River would be controlled through the dam except during flood events. Flood flows would be controlled via a spillway over the central part of the dam and a stilling basin would be located at the toe of the spillway to dissipate energy and to divert the flow into the river channel downstream.

The baseline characteristics of these tributaries (including the Te Awa Makarara/Teviot River impacted by the dam) were variously surveyed by Cawthron, Fish & Game, and DOC. At each site surveyed by Cawthron, spot measurements of water temperature, specific conductance (a measure of its ability to conduct electricity as an indicator of ionic content), dissolved oxygen concentration and saturation were undertaken together with measurements of water clarity. An assessment of the physical stream habitat was undertaken using a Rapid Habitat Assessment protocol which included assessing the provision of habitat for biota and associated functions such as the delivery/retention of sediment, nutrients and organic matter. Macroinvertebrate and fish populations were also surveyed.

The findings of that survey, and the potential impacts of the project on those characteristics, are described below.

5.2.1 Baseline environmental characteristics: water and aquatic ecology

The depths of the tributaries range from 0.13m-0.44m, with widths between 0.5m-7.9m.[79] They feature a mixture of sand and gravel beds, limited vegetation cover, and very moderate slopes. In general, the presence of gravel in these tributaries is concentrated in the lower reaches of the streams (closest to the lake). Bedrock tends to dominate the substrate of streams in their higher reaches.[80]

In general terms, Cawthron note that all the tributaries exhibit similar water quality with the data indicating that none of the tributaries are experiencing severe water quality conditions. In particular:

- Dissolved oxygen in all sites was consistently within healthy ranges indicating that no sites were experiencing high periphyton biomass or anoxia at the time of sampling[81]
- Nutrient levels were very low, particularly nitrogen which is likely limiting the growth of periphyton and macrophytes in these tributaries[82]
- Concentrations of ammonia were also very low and within the A-band threshold in the NPS-F for ammonia toxicity[83]

[79] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project,* at page 35

[80] Otago Fish & Game Council. (2022). *An Investigation into Lake Onslow Brown Trout Spawning Habitat Availability at Increased Lake Heights,* at page 9

[81] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project, at* pages 34 – 35

[82] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page iii

[83] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page 37

- Water clarity was visibly affected by coloured dissolved organic matter, which indicates the input of humic dissolved organic matter from the surrounding wetland areas.[84]
- More variability was identified in the instream aquatic habitat characteristics, with the tributaries exhibiting a wide range of scores from the Rapid Habitat Assessment (33-70).[85]

Periphyton biomass (measured as chlorophyll *a)* was in low-moderate ranges, most likely reflecting the low nutrient status in the streams limiting growth of periphyton. Based on those chlorophyll *a* levels, the tributaries would fall into the highest band for ecosystem health under the NPS-F.

Historical monitoring data of periphyton within Te Awa Makarara/Teviot River's main stem has also confirmed the existence of various algal taxa. While that branch could not presently be described as 'unhealthy', Cawthron states that the presence of filamentous green algae is a warning sign of undesirable changes that may compromise fish and invertebrate habitat and aesthetic values.[86]

Macrophyte cover was identified within the main stem of Te Awa Makarara/Teviot River, as was the native aquatic plant red pondweed *Potamogeton cheesmanii,* which appears to be a regular feature in certain parts of that river. The presence of this species signals the potential for aquatic weed species dispersed by the pumping operation to become established in the main stem of this River, but further work would be required to ascertain this. No macrophytes were observed during the sampling in any other tributary which may be attributed to the predominantly gravel beds that might be too mobile for macrophyte communities to establish.

Macroinvertebrate surveys undertaken by Cawthron in May and December 2021 found that invertebrate communities were generally well represented in variety and abundance. Mayflies, stoneflies and caddis flies (taxa that are generally considered indicative of good stream health and a key food source for many fish and insectivorous wading bird species) were present in all but one of the surveyed tributaries. However, these waterways scored below the NPS-F bottom line for macroinvertebrates, which could, in some circumstances, be indicative of severe organic pollution or nutrient enrichment. In Cawthron's view, this grade is not entirely appropriate in this instance because the natural character of the streams is not habitat that EPT[87] taxa are generally found in high abundance.

Trout spawning occurs in the tributaries to Lake Onslow where specific physical characteristics are present including suitable gravel sizes and stream velocities. The tributaries of the Lake also contain juvenile rearing habitat.[88] Suitable velocities for spawning are generally found in relatively low gradient areas, and these need to be directly hydraulically connected to the Lake. Shallow water and unpassable drops impede the access of trout upstream into tributaries.[89]

DOC undertook fish surveys within the tributaries during September 2021-January 2022 using a range of methods. Most of the surveyed tributaries provide moderate habitat diversity for fish and shading scores were typically low due to the absence of trees and other geological

[84] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page iii

[85] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project,* at page 33

[86] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project,* at page 44

[87] Ephemeroptera, Plecoptera and Trichoptera

[88] Otago Fish & Game Council. (2022). *An Investigation into Lake Onslow Brown Trout Spawning Habitat Availability at Increased Lake Heights*, at page 2

[89] Otago Fish & Game Council. (2022). *An Investigation into Lake Onslow Brown Trout Spawning Habitat Availability at Increased Lake Heights*, at page 3

features. [90] Figure 5.6, Figure 5.7 and Figure 5.8 illustrate the locations and fish species that were discovered during DOC's survey work in this catchment.[91]

Further information on the characteristics of specific habitats and the accommodated species identified within the principal tributaries is described further below.

[90] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project,* at page 32

[91] s 9(2)(i)

Figure 5.6: Main stem Te Awa Makarara/Teviot River survey sites

s 9(2)(i)

Figure 5.7: Te Awa Makarara/Teviot River North Branch, Manor Burn and Bonds Creek survey sites

s 9(2)(i)

Figure 5.8: Boundary Creek, Te Awa Makarara/Teviot River South Branch and Armstrong Creek survey sites

s 9(2)(i)

5.2.1.1 Main stem of Te Awa Makarara/Teviot River

There is reasonably low diversity of fish communities in the main stem of Te Awa Makarara/Teviot River. Surveys conducted by Cawthron have confirmed the presence of brown trout and common bully in the upper reaches of Te Awa Makarara/Teviot River below the existing dam. These species were not identified in any of the surveyed tributaries of the stem, as each tributary has a significant waterfall above their confluences with the Te Awa Makarara/Teviot River which prevent colonisation by brown trout.

Additional eDNA sampling of two Te Awa Makarara/Teviot River tributaries confirmed that the Threatened-Nationally Critical Teviot flathead galaxias was the only galaxiid species present.

5.2.1.2 Te Awa Makarara/Teviot River North Branch

Freshwater habitats in this catchment are predominantly 1st and 2nd order streams,[92] originating as fens and seepages surrounded by sedge and tussock grasslands, moss fields and cushion fields. Some shrub-land vegetation is confined to steeper gullies and parts of the primary channel of the river. Instream habitat varies from schist alluvium, overhanging vegetated banks over bedrock, to muddy based weedy seepage channels and pools situated in cushion fields. [93]

Brown trout were the most abundant freshwater fish species observed throughout the waterways of the Te Awa Makarara/Teviot River North Branch. Trout spawning areas were also identified within this branch.[94]

Three new populations of the Threatened-Nationally Critical Teviot flathead galaxias were discovered in the Upper Te Awa Makarara/Teviot River North Branch, all three of which are located upstream of the proposed inundation area (and are located within the Manorburn Conservation Area). The combined linear distance of the new observed habitat was 1740m. [95] The areas where Teviot flathead galaxias were located were all in places where trout are excluded from the waterway.

5.2.1.3 s 9(2)(i) [redacted]

[redacted]

[redacted]

5.2.1.4 s 9(2)(i) [redacted]

[redacted]

92 Further information about stream order can be found in section 5.6 of this Chapter
93 Department of Conservation. (2022). *Survey Report – Freshwater Fish Values of Lake Onslow,* at page 6
94 Department of Conservation. (2022). *Survey Report – Freshwater Fish Values of Lake Onslow*, at page 7
95 Department of Conservation. (2022). *Survey Report – Freshwater Fish Values of Lake Onslow*, at page 7
96 Department of Conservation. (2022). *Survey Report – Freshwater Fish Values of Lake Onslow*, at page 12

s 9(2)(i) [redacted]

[redacted]

5.2.2 Potential impacts of the project on baseline characteristics

The main tributaries will lose several kilometres of their length to the Lake and some sub-tributaries draining into those will also lose substantial amounts. Under the 3TWh option, 175km of stream length would be lost, while under the 5TWh option, 215km of stream length would be lost. Approximately 352km of stream length within the Onslow basin would remain outside the inundation area, as shown in Figure 5.9.

[97] Department of Conservation. (2022). *Survey Report – Freshwater Fish Values of Lake Onslow*, at page 13
[98] Department of Conservation. (2022). *Survey Report – Freshwater Fish Values of Lake Onslow*, at page 14
[99] Department of Conservation. (2022). *Survey Report – Freshwater Fish Values of Lake Onslow*, at page 14

s 9(2)(i)

s 9(2)(i)

Although the inundated waterways may physically reappear during periods of water drawdown, ecologically they will not be able to repair as streams, due to the time required for riparian vegetation to re-establish. This inundation will result in the loss of some freshwater habitats and alteration of some ecosystems. Middle reaches will become lower reaches, with a greater influence from the lake, which may result in slower flows or greater accessibility to trout. Further, some remaining streams may become too short to support certain fauna or ecosystem services. This loss is therefore considered to have a very high level of effect. [100]

There is the potential for didymo to become established in the outflowing Te Awa Makarara/Teviot River.[101] In addition, the presence of *Potamogeton* sp, and *Myriophyllum* sp in Boundary Creek indicates potential habitat for the establishment of aquatic pest plant species, should they be introduced to these particular locations as a result of the higher lake levels.

Specifically, inundation would result in the loss of high-quality tussock stream and wetland habitat occupied by Teviot flathead galaxias. This includes two tributaries of Lake Onslow that are occupied by 25% of the known Teviot flathead galaxias population,[102] and which represent approximately 15% of the known linear stream habitat for this species. The majority of both of these habitats is within the inundation area, so would be lost.

Four waterways downstream of the proposed dam, containing 67% of the known linear stream habitat for the Teviot flathead galaxias population, are located above the proposed subterranean waterways. The proposed tunnels will not directly affect the surface topography of waterways containing Teviot flathead galaxias, however there are unknown consequences for the hydrology of these catchments.[103] Installation of roading and infrastructure will directly impact these waterways. As such, a total of 82% of the known stream habitat containing this species has the potential to be lost and/or impacted by the project, either through inundation and/or possible effects of the tunnels.

The sensitivity of Teviot flathead galaxias to exotic fish predators such as brown trout means that it would not be able to live in the enlarged lake, and areas of flooded stream habitat lost to inundation would not be offset in any way by the creation of more lake habitat. [104]

There is also the potential for elvers or kōaro to be transferred into Lake Onslow in pumped source water, which could significantly affect Teviot flathead galaxias populations through predation, although Cawthron acknowledge that it is uncertain as to how likely such transfers would be. [105]

Overall, it is considered that there will be a significant impact on Teviot flathead galaxias due to the limited number of populations, and their limited distribution. Unlike the dusky galaxias which are present in other catchments, the Te Awa Makarara/Teviot River, its tributaries, and an outlying record in Red Swamp Creek of the Taieri River, represent the *global* distribution of the Teviot flathead galaxias.[106]

---

[100] Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme,* at page 68

[101] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, page 72

[102] Department of Conservation. (2022). *NZ Battery Project – Lake Onslow Option: Assessment of Conservation Values at Lake Onslow*, at page 59

[103] Department of Conservation. (2022). *Proposed Infrastructure impacts to Teviot flathead galaxias habitats, Teviot River*, at page 4

[104] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page iv

[105] Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*, at page iv

[106] Department of Conservation. (2022). *Survey Report – Freshwater Fish Values of Lake Onslow,* at page 2

Inundation of Lake Onslow would also result in the loss of known habitat for dusky galaxias in the Te Awa Makarara/Teviot South Branch catchment, either by inundation, or by the breach of existing waterfall barriers that currently prevent brown trout from preying upon this species.

Raising the level of Lake Onslow is also predicted to reduce the size of the current brown trout spawning and rearing habitat. Fish & Game has undertaken field work to predict the extent to which trout spawning habitat in the tributaries to Lake Onslow are likely to be affected by inundation. Creation of the proposed upper reservoir to a level of 765mRL (5TWh FSL) would reduce the amount of trout spawning habitat to approximately 0.34% of the amount currently available.[107] Approximately 40% of the current habitat would be available at the minimum operating level of 695mRL, however this habitat is likely to be degraded due to sedimentation and loss of riparian zones. The overall loss of spawning habitat is largely due to there being very little suitable gravel within tributaries above the 760m contour, the gradient of the tributaries, and the presence of hydraulic barriers. The reduction in both spawning and rearing habitat means that there is unlikely to be enough production of juveniles to support the trout fishery in an enlarged Lake Onslow.[108]

5.2.3 Options to address impacts

Wildlands consider that mitigation of the loss of stream length in the Lake Onslow catchment will require extensive restoration of greater lengths of stream, ideally upstream in the catchment or in similar environments nearby. If reaches of waterway in the catchment have been channelised, these can be restored to the original flow paths. Wildlands note that stream restoration is more than just planting the riparian zone and should also include actions to improve instream habitat complexity and availability.[109]

s 9(2)(i) [redacted]

[redacted]

[redacted]

107 Otago Fish & Game Council. (2022). *An Investigation into Lake Onslow Brown Trout Spawning Habitat Availability at Increased Lake Heights*, at Appendix 1

108 Otago Fish & Game Council. (2022). *An Investigation into Lake Onslow Brown Trout Spawning Habitat Availability at Increased Lake Heights*, at page 13

109 Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme,* at page 69

110 Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme,* at page 70

111 Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme,* at pp 70-71

s 9(2)(i) [redacted]

The Otago Fish & Game Council has provided some comments on the potential to mitigate for brown trout habitat loss, noting that it would be difficult.[115] One option is to introduce spawning gravel to the remaining reaches of the inundated tributaries, but this is not likely to be successful in creating suitable habitat as the streams are steep and contain barriers to trout. There is also a chance that these reaches of the tributaries would not be hydraulically accessible during periods when the proposed reservoir is at low water levels.

Another option is to construct a spawning race, which would need to be 'groomed' regularly to prevent the build-up of didymo (which could be introduced via source water pumped up from the Mata-Au/Clutha River). The feasibility of constructing a spawning race is also dependent on the availability of suitable spawning shingle. [116]

5.3 Wetlands

5.3.1 Baseline environmental characteristics

There is approximately 1330ha of wetland habitat within the greatest inundation area of the Lake Onslow basin,[117] much of which provides a crucial habitat for a range of other species (plants, insects and birds).[118] s 9(2)(i) [redacted] Some of these wetlands have been formally recognised within the Central Otago District Plan and the Regional Plan: Water and are shown in Figure 5.11. All wetlands above 800mASL are also identified as being regionally significant in the Regional Plan: Water.[119] In addition, the Otago Regional Council has undertaken work to identify potential ecosystem types within the Otago region, including potential wetlands, as shown in Figure 5.12.

---

112 Department of Conservation. (2022). *Paper: Translocation Proposal–Teviot flathead galaxias.*

113 Department of Conservation. (2022). *Paper: Translocation Proposal–Teviot flathead galaxias*, at page 41

114 Department of Conservation. (2022). *Paper: Translocation Proposal–Teviot flathead galaxias*, at pages 42-46

115 Otago Fish & Game Council. (2022). *An Investigation into Lake Onslow Brown Trout Spawning Habitat Availability at Increased Lake Heights*, at page 14

116 Otago Fish & Game Council. (2022). *An Investigation into Lake Onslow Brown Trout Spawning Habitat Availability at Increased Lake Heights*, at page 14

117 Wildlands Consultants Limited. (2021). *Desktop Assessment of Vegetation and Botanical Values in the Vicinity of the Proposed Lake Onslow Pumped Hydro Storage Project, Otago,* at page 12

118 Wildlands Consultants Limited. (2021). *Desktop Assessment of Vegetation and Botanical Values in the Vicinity of the Proposed Lake Onslow Pumped Hydro Storage Project, Otago,* at page 6

119 Otago Regional Council. (2009). *Otago Regional Plan: Water*, Policy 10.4.1A(c)

s 9(2)(i)

s 9(2)(i) [redacted]

Within the areas where field survey was undertaken during 2021, wetlands account for approximately 16% of the surveyed footprint, s 9(2)(i) [redacted]. A range of wetland types are present, with the vegetation in most of the wetlands being relatively intact, comprised primarily of indigenous wetland species, and containing Threatened or At Risk species. All contained exotic species to a lower degree.[120]

Within the proposed inundation area, wetlands were present at all elevations and were most commonly associated with water bodies, gullies, and damp depressions, and mostly distributed at lower elevations within the inundation area. Vegetation within the wetlands that were surveyed were dominated by sedges, herbs and mosses, with some low stature shrubs.[121]

Wetland areas provide important moult sites for pūtangitangi/paradise shelduck *Tadorna variegata* and may provide foraging and breeding habitat for a range of Threatened and At Risk

---

[120] Department of Conservation. (2022). *NZ Battery Project – Lake Onslow Option: Assessment of Conservation Values at Lake Onslow,* at page 33

[121] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity and Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago,* at page 25

birds.[122] The wetlands are also important for grass moths, looper moths and ghost moths. These species have strict habitat requirements and limited distributions.

5.3.1.1 Fortification Creek

The Fortification Creek wetland complex is the most outstanding wetland complex within the proposed inundation area, containing ephemeral and other wetland types. Ephemeral wetlands are both naturally uncommon and critically endangered ecosystems, and the Fortification Creek wetland complex is of particular significance given its large area (approximately 526ha), intact nature and diversity of species. It is not replicated anywhere else in the Otago Region.[123] It is also a nationally rare wetland type[124] which is considered to be of national significance.[125]

The lower reaches of the Fortification Creek wetland complex and the South Branch of Te Awa Makarara/Teviot River form fine-scale scroll plains dominating a mosaic of marsh, swamp and ephemeral wetlands[126]. These remain dominated by indigenous vegetation and provide habitat for a number of Threatened and At Risk plant species. [127] The wetland complex is also understood to have the largest known population of the Threatened-Nationally Critical kettlehole cudweed in Otago, and one of the largest populations nationally. The Fortification Creek wetland complex may have the largest population of *Deschampsia* cespitosa in Otago.[128] It also has value as a moult habitat for the pūtangitangi/paradise shelduck.

Wetlands of similar type are located in the Greenland Reservoir basin and the Loganburn Reservoir basin, but are less extensive and more modified than the Fortification Creek wetland complex. [129]

Although the value of the wetlands at Fortification Creek and the South Branch Te Awa Makarara/Teviot River scroll plain wetlands are generally appreciated (based on surveys undertaken during tenure review processes), the full extent of ecological values in the wetland complex has not yet been described as access to these wetlands was not granted by landowners during the 2021 survey undertaken by Wildlands.

5.3.1.2 s 9(2)(i) [redacted]

[redacted]

---

122 s 9(2)(i) [redacted]

123 [redacted]

124 [redacted]

125 [redacted]

126 [redacted]

127 [redacted]

128 [redacted]

129 [redacted]

130 [redacted]

s 9(2)(i) [redacted]

[redacted]

Table 5.3 below sets out a comparison of the wetland areas within the two proposed inundation areas for the upper reservoir at Lake Onslow.[132]

Table 5.3: Comparison of wetland areas remaining at different elevation thresholds for the Lake Onslow basin

Altitude	**Ephemeral wetland (ha)**	**Red tussock, *Schoenus pauciflorus* tussockland (ha)**	***Schoenus pauciflorus* sedgeland (ha)**	**Totals (ha)**
Lake Onslow <745mRL	1.2	1211.8	57.1	1270.1
Lake Onslow 765mRL	-	44.4	14.9	59.9

Source: Te Rōpū Matatau, adapted from Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity and Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago,* at page 12

5.3.1.3 s 9(2)(i) [redacted]

[redacted]

[redacted] All these wetlands are described as having a high degree of wetland naturalness. These types of wetland (marshes) are scarce in Otago in terms of their ecological or physical character with less than 15% of marshes remaining in Otago.[133]

No field survey work has been undertaken to date outside the proposed Lake Onslow inundation area, including the wetlands described above. Given the area has not been fully surveyed, there is also the potential for a range of other wetland habitats to be present in both the inundation area and elsewhere (particularly bordering the Mata-Au/Clutha River) that are not formally recognised in planning documents.

[131] Otago Regional Council. (2022). Middle Swamp. https://www.orc.govt.nz/managing-our-environment/water/wetlands-and-estuaries/central-otago-district/middle-swamp accessed 11 August 2022

[132] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity and Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago,* at page 12

[133] Otago Regional Council. (2022). Island – Blocks Pond Marshes. https://www.orc.govt.nz/managing-our-environment/water/wetlands-and-estuaries/central-otago-district/island-blocks-pond-marshes accessed 11 August 2022

5.3.2 Potential impacts of the project on baseline values

Large wetland complexes in upland basin floors in Central Otago have historically been significantly reduced in extent because water storage reservoirs were often located in these basins. The filling of Lake Onslow, the Greenland Reservoir and the Loganburn Reservoir inundated the three largest of these wetland complexes that historically were present in this part of the Otago uplands. [134]

This loss is consistent with the national experience, with approximately 90% of Aotearoa New Zealand wetlands having been drained since human settlement. Between the period 2001-2016, at least 214 individual wetlands with an area of 1247ha were lost. As a result, national policy direction (NPS-F) requires the avoidance of any further loss of natural wetlands.[135]

Based on desktop data, there is at least 1330ha of wetland habitat within the area that would be inundated by the proposed upper reservoir (5TWh option), and approximately 1270ha of wetland habitat that would be inundated by the proposed upper reservoir (3TWh option), including the Fortification Creek Wetland, Boundary Creek Wetland, and Middle Swamp. Wetlands less than 0.5ha are not captured in this estimation.[136] Most of the wetlands in the maximum inundation footprint area comprise red tussock *Schoenus pauciflorus* tussockland (1212ha). [137]

The loss of these wetlands is significant not only due to the values of the wetlands, but also in relation to the habitat that they provide for plants, birds, and invertebrates. The effects arising from the loss of wetlands on wetland specialised fauna are considered to be very high,[138] and the effects on moths ranging from low to very high depending on the distribution and habitat requirements of each species.[139]

The project also has the potential to affect wetlands beyond the inundation area. This includes the known wetlands identified in Figure 5.11 above, and as yet unidentified wetlands. None of the wetlands outside the inundation area in Figure 5.11 are directly within the footprints of the proposed offtake or reservoirs, but there is the potential for construction related impacts to affect these wetlands. This is particularly the case for the wetlands which are located in close proximity to existing roads if those roads require any upgrades and/or rerouting.

5.3.3 Options to address impacts

The unavoidable loss of extensive, diverse, and rare wetlands within the inundation area will be one of the most significant adverse effects arising from the project.[140] Wetlands will not re-establish around the new lake because of the fluctuating water levels that are proposed. [141]

[134] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity and Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago,* at page 17

[135] Ministry for the Environment and Stats NZ. (2020). *New Zealand's Environmental Reporting Series: Our Freshwater 2020*

[136] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity and Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*, at page 12

[137] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity and Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago,* at page 12

[138] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity and Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago,* at page 33

[139] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity and Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago,* at page 44

[140] Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme*, Executive Summary

[141] Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme,* at page 12

Options available to offset for the loss of wetland habitat fall into three main categories:

- Transfer of existing wetland habitat and/or biota to new locations
- Protection and enhancements of existing wetlands in the local area
- Recontouring land to encourage the expansion of existing scroll plain wetlands that will be inundated.

While there are options for the transfer of wetland biota to new sites, these are associated with a high degree of risk. Consequently, seeking to address adverse effects on wetlands is considered to be best focussed on protecting and enhancing other similar wetlands in the local landscape, accepting that even this measure successfully implemented will result in a net loss of wetland extent due the sheer scale of wetland loss. [142]

s 9(2)(i) [redacted]

[142] s 9(2)(i) [redacted]

[143] [redacted]

s 9(2)(i)

[redacted]

[redacted] [145]

Further details about the site-specific characteristics of each site are set out in **Appendix E.5 in Volume Two**.

Threatened and At Risk plant species have a strong association with wetlands, but these should be more amenable to direct transfer to unaffected wetland sites, or having existing populations enhanced at other wetland sites. Transfer of notable plant species should be attempted for species of wetland and terrestrial habitats and is potentially feasible for 34 of the 47 Threatened or At Risk plant species identified as being affected or potentially affected by the project.[146]

The third option that is potentially possible to offset the loss of the scroll plain wetlands at Fortification Creek and South Branch Te Awa Makarara/Teviot River is to reduce the gradient of the valleys upstream of the current scroll plains so that the streams can begin to meander and create oxbows across it. This option has not been subject to a detailed feasibility and cost assessment, and would require significant earthworks and careful measurements and calculations to ensure the correct gradients are achieved. Earthworks would need to be completed prior to the inundation of the proposed upper reservoir so that plants and invertebrates could be transferred to the new area.[147]

Significant research would need to be undertaken to determine the success of any attempt to create a scroll plain, and it is unlikely that a scroll plain has ever been deliberately created elsewhere. Stream channels are often created, but with varying degrees of success. The necessary earthworks would likely overlap with important ecosystems that might not be suitable for wetland or scroll plain creation, and there is the potential to overlap current habitat for the dusky galaxias. Soils in the area may also be too thin to support this undertaking.[148]

5.4 Mata-Au/Clutha River

The Mata-Au/Clutha River (including Lake Roxburgh) is also central to the proposed project as:

- It is intended to provide a water source to form the enlarged upper reservoir at Lake Onslow; and

144 Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme*, Executive Summary at page 22

145 Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme* (Wildlands) (2022), Executive Summary at page 22

146 Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme*, Executive Summary

147 Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme*, Executive Summary at page 72

148 Wildlands Consultants Limited. (2022). *Assessment of Options to Address the Ecological Effects of the Proposed Lake Onslow Pumped Hydro Scheme*, Executive Summary at page 72

- It will be the point at which water will be discharged back into the River once the storage capacity of the lower reservoir is full, or alternatively the point of direct discharge of water from the project in the case of the Lake Roxburgh option.

If the lower reservoir is constructed at s 9(2)(i) it is also likely that diversion and/or dewatering of the Mata-Au/Clutha River will be required to construct the offtake structure. There is also the potential for in-river structures to be established as part of the proposed project, and ongoing dredging may also be necessary to maintain flows within the River. For the Lake Roxburgh option, isolating areas from the Lake would also be required to construct the intake structure, allowing construction in the dry behind a levee on un-excavated rock which would be removed on completion.

As set out in NIWA's report on the baseline values of the Mata-Au/Clutha River**,** the Mata-Au/Clutha River below Roxburgh Dam is predominantly a single thread river, which splits into two branches at Balclutha. The main tributaries to the Mata-Au/Clutha River include:

- Kawarau River
- Manuherikia River
- Tuapeka River
- Pomahaka River

Between Roxburgh and Balclutha, the Mata-Au/Clutha River is relatively deep and swift, with limited marginal littoral zones.[149] The entire Mata-Au/Clutha River is recognised as a statutory acknowledgement area under Schedule 40 of the Ngāi Tahu Claims Settlement Act 1998. Kāi Tahu has extensive connections with the Mata-Au/Clutha River and the river takes its te reo Māori name from a Kāi Tahu whakapapa that traces the genealogy of water. The Mata-Au/Clutha River is seen as a descendant of the creation traditions.

Contact Energy operates a series of hydro schemes within the Mata-Au/Clutha River, with hydro generating facilities and dams at Clyde and Roxburgh. Lake Roxburgh was formed following the construction of the Roxburgh Dam in 1949 and commissioning of the hydro-electric power station between 1956 and 1962. The resource consents which authorise the operation of this Dam expire in 2042. The river is unimpeded by dams downstream of the Roxburgh Dam. There is a range of other consents to take and use water within the catchment for uses such as irrigation, stock water and domestic water supply.

Understanding the volume of water that can be taken under each of these consents, the maximum rate at which water can be taken, whether there are any seasonality constraints on the take, and the ultimate expiry of the consents assists with building a picture of the overall water that is 'available' to existing consented users. In the case of the Mata-Au/Clutha River the current Water Plan also permits up to one million litres per day (0.01m^3/s) to be taken as a permitted activity per landholding.

At the time of writing, the Otago Regional Council is unable to advise what is the total sum of the consented takes downstream of the Roxburgh Dam is, or the extent to which tributaries and groundwater flows may contribute to the flow in the River at various points along the main stem.

Based on publicly available data on the Otago Regional Council website which shows details of consents issued after 2016, there is a range of existing consents to take and use water from the Mata-Au/Clutha River downstream of the Roxburgh Dam, as well as consents to take and use water within the wider catchment. These water takes are generally for the purpose of irrigation, stock water supply, frost fighting, and domestic water supply.

[149] NIWA. (2022). *Hydrology, water quality and ecology of the lower Clutha*, page 18

Overall, the current approach to managing water takes from the Mata-Au/Clutha River downstream of the Roxburgh Dam is relatively permissive, and the extent of existing consented takes is uncertain. It is also a situation that will be subject to ongoing evolution not only as consents expire and come up for renewal, but also as associated regulatory documents that manage the take and use of water such as the Regional Plan: Water come up for review and go through the necessary statutory processes.

The pORPS describes the Freshwater Management Unit (FMU) and rohe that are proposed to be used to manage Otago's freshwater resources. The Mata-Au/Clutha River is within the proposed Mata-Au/Clutha FMU and is made up of the following rohe:

- Upper lakes
- Dunstan
- Manuherikia
- Roxburgh
- Lower Clutha

Figure 5.13 shows the location and extent of the Mata-Au/Clutha FMU and the associated rohe.

s 9(2)(i)

[redacted]

The physical components of the proposed project will be located within the Roxburgh rohe, but the proposal to take and discharge water from the Mata-Au/Clutha River also has the potential to affect the entirety of the Lower Clutha rohe.

5.4.1 Baseline environmental characteristics: water

The Mata-Au/Clutha River is the longest river in the South Island (338km) and has the highest mean flow in the country (614m^3/s).[150] The catchment of the river is large (21,022km^2), with Lakes Wakatipu, Wānaka and Hāwea feeding the river in the upper catchment. Approximately 40% of the catchment lies above 1000m and this area provides seasonal snowmelt in the spring and early summers. Less than 0.5% of the catchment is above the permanent snow line (approximately 2400m) but this still influences the flow regime within the catchment due to snow melt. [151]

Flow into Lake Roxburgh has been monitored by Contact Energy with data available back to the 1930s. The average flow into the lake is 509m^3/s. A maximum recorded inflow of 3327m^3/s was recorded in 1999, and the median flow is 467m^3/s.[152]

The flow regime of the lower Mata-Au/Clutha River is also relatively well-recorded and documented, with river flow data for the lower Mata-Au/Clutha River available at 10 locations, including, but not limited to:

- Below Roxburgh Dam
- Ettrick
- Tuapeka Mouth
- Balclutha

As illustrated in Figure 5.14 below, the Mata-Au/Clutha River has a broad flow range with flow rates ranging between 100m^3/s and 1965m^3/s. Durations of high river flows (above 790m^3/s) can generally last for around 50 days. Flow monitoring data since 2000 indicates the Mata-Au/Clutha River has a mean flow of 516m^3/s just downstream of the Roxburgh Dam.[153] Flows in the River are generally highest in summer and late autumn, and the daily range of flow in the River is generally between 400 and 600m^3/s.[154]

150 NIWA. (2022). *Hydrology, water quality and ecology of the lower Clutha,* at page 7. Measured at Balclutha 1947–1999.

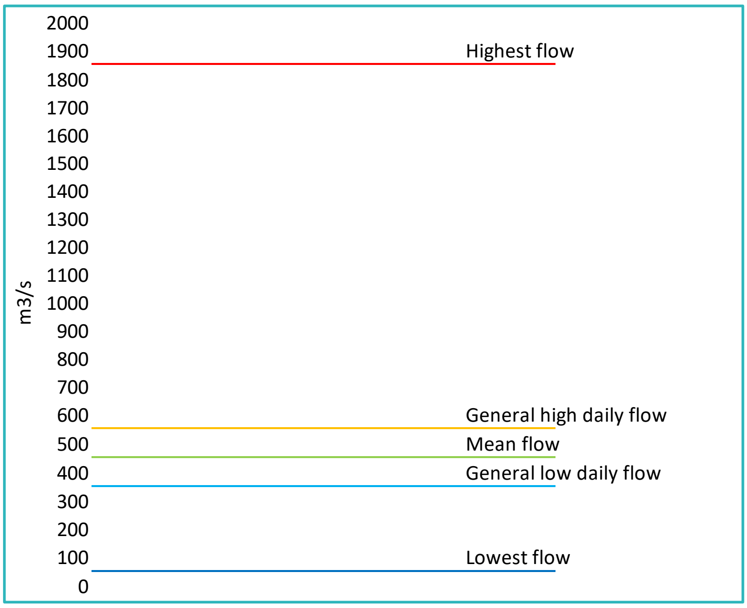
151 NIWA. (2022). *Assessment of Lake Onslow climate, hydrology and ecology,* at page 20

152 Te Rōpū Matatau. (2021). *Hydrology and Hydrological Report* (NZBLO-TRM-01A-021-RPT-HYD-000186-A), page 43

153 NIWA. (2022). *Hydrology, water quality and ecology of the lower Clutha,* Executive summary

154 NIWA. (2022). *Hydrology, water quality and ecology of the lower Clutha,* at page 7

Figure 5.14: Flow rates in the Lower Mata-Au/Clutha River



Source: Te Rōpū Matatau

Analysis of recorded average daily flow data by Te Rōpū Matatau of the discharge from Roxburgh Dam indicates that on average flow in the river was above 400m^3/s for 73% of the time and above 500m^3/s 50% of the time.[155] Contact typically operates the system with a daily diurnal fluctuation. The lakes in the upper part of the catchment have a significant influence on the flows in the river given that they provide approximately 75% of the flow seen 140km downstream at Balclutha. [156]

LAWA collects water quality data at two sites on the lower Mata-Au/Clutha River: one at Millers Flat, and another at Balclutha.[157] Figure 5.15 below illustrates the *current* water quality attributes of the lower Mata-Au/Clutha River at Millers Flat and Balclutha as compared to the NPS-F attributes and national bottom lines.

[155] Te Rōpū Matatau. (2021). *Hydrology and Hydrological Report* (NZBLO-TRM-01A-021-RPT-HYD-000186-A), page 48

[156] NIWA. (2022). *Hydrology, water quality and ecology of the lower Clutha,* at page 7

[157] Lawa.org.nz, data summarised in NIWA. (2022). *Hydrology, water quality and ecology of the lower Clutha,* at pages 14-15

Figure 5.15: Water quality - Lower Mata-Au/Clutha River

Attribute	Mata-Au / Clutha River existing data
Total Nitrogen (lakes)	
A	N/A as attribute is applicable to lakes only. LAWA data indicates that the river is in the best 25% of all sites.
B	
C	
NBL	
D	
Total phosphorous (lakes)	
A	N/A as attribute is applicable to lakes only. LAWA data indicates that the river is in the best 25% of all sites at Balclutha, but the worst 25% of sites at Millers Flat.
B	
C	
NBL	
D	
Ammonia (rivers and lakes)	
A	Millers Flat, Balclutha in A band
B	
NBL	
C	
D	
Suspended fine sediment (rivers)	
A	
B	
C	
NBL	
D	Millers Flat, Balclutha in D band
Dissolved reactive phosphorus (rivers)	
A	Millers Flat, Balclutha in A band
B	
C	
D	

Source: Te Rōpū Matatau

The water quality of the lower Mata-Au/Clutha River is principally determined by the quality of water in Lake Roxburgh given that there are no sizable inflows when compared to the river flow below the Roxburgh Dam.[158] Although based on small sample sizes, limited locations and times, NIWA undertook water sampling from Lake Roxburgh and at Millers Flat on three occasions in 2021.[159] These were analysed for total suspended solids (TSS) and particle size distribution. Water quality was also sampled (nutrient and chlorophyll *a* concentrations) to determine the trophic state.

TSS measured at Millers Flat was similar to that at Lake Roxburgh. The clarity of the water in the Mata-Au/Clutha River has been described as milky bluish-green and clarity is often low. This has been attributed to fine suspended solids and is partly natural due to glacial sediments and partly due to legacy sediments from gold mining and other anthropogenic activities.[160]

Overall, the data indicates that water quality of the Mata-Au/Clutha River at Millers Flat is excellent, and that the water quality at Balclutha is excellent overall (except for water clarity and E. coli concentrations). However, looking to the future, five-year trends of several water quality attributes at both sites indicate that water quality is degrading.[161]

5.4.2 Baseline environmental characteristics: aquatic ecology

Although no formal monitoring of periphyton within the Mata-Au/Clutha River occurs, the cover of periphyton has been visually assessed at approximately monthly intervals at Millers Flat and Balclutha since 1990. That assessment indicates that periphyton has increased over that time with didymo discovered in the lower Mata-Au/Clutha River in 2006. It has since become established in the entire river. Pest plant species including *Lagarosiphon major* and *Elodea canadensis* are also known to be present in the Mata-Au/Clutha River system.

Macroinvertebrates have been sampled annually in the Mata-Au/Clutha River at Millers Flat between 1990 and 2019.[162] Based on the five-year period between 2015-2019 the minimum, median, mean and maximum Macroinvertebrate Community Index (MCI) values at Millers Flat all fall below the national bottom line, falling in the D-band as illustrated in Figure 5.16 below.

Figure 5.16: MCI score: Lower Mata-Au/Clutha River

Attribute	Mata-au / Clutha River existing data
Macroinvertebrates (wadeable rivers)	
A	
B	
C	
NBL	
D	Millers Flat in D band

Source: Te Rōpū Matatau

Waterbodies that have an MCI score in the D-band indicate that severe organic pollution or nutrient enrichment is present. Macroinvertebrate communities are largely composed of taxa that are insensitive to inorganic pollution/nutrient enrichment.

However, NIWA notes that high turbidity in the water below Roxburgh dam has been suspected to impair some water uses (such as swimming and fishing) and this may limit the presence and

[158] NIWA. (2022). *Hydrology, water quality and ecology of the Lower Clutha,* at page 16

[159] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology,* at page 50

[160] NIWA. (2022). *Hydrology, water quality and ecology of the lower Clutha,* at page 16

[161] NIWA. (2022). *Hydrology, water quality and ecology of the lower Clutha,* at page 15

[162] At the time of writing, NIWA only had access to quality assured data for this period, but macroinvertebrates are being surveyed annually.

diversity of macroinvertebrates. Additionally, the establishment of didymo often results in degraded macroinvertebrate communities and thus lower MCI scores.[163]

Access to the riverbanks of the Mata-Au/Clutha River is often obstructed by willows which makes access difficult. As a consequence, the mainstem of the River has received relatively little attention from fisheries researchers. Most records of freshwater fish are from the tributaries to the Mata-Au/Clutha River.[164]

Records of the presence of fish in the lower Mata-Au/Clutha River range from 1984–2000 from three principal sources. These results indicate that 12 species of native fish have been recorded in the mainstem of the River, and an additional two species from tributaries (14 in total). Of these species, 11 are diadromous, which means that they need access to the sea to complete their life history. Three species of salmonid as well as perch are known to reside within Lake Roxburgh.

As some of these diadromous species have been found in tributaries to the Mata-Au/Clutha River it indicates that the River provides a 'thoroughfare' for these types of species.

A summary of the species that have been recorded to date in the lower Mata-Au/Clutha River and its tributaries is set out in Table 5.5.

Table 5.5: Species of fish in the lower Mata-Au/Clutha River

Conservation Status	Species
Threatened -Nationally Critical	Nil
Threatened-Nationally Endangered	Roundhead galaxias *Galaxias anomalus* (not diadromous)
Threatened-Nationally Vulnerable	Kanakana/lamprey *Geotria australis*
Threatened-Nationally Increasing	Nil
At Risk-Declining	Tuna/longfin eel *Anguilla dieffenbachii* Īnanga *Galaxias maculatus* Kōaro *Galaxias brevipinnis* Giant kōkopu *Galaxias argenteus* Torrentfish *Cheimarrichthys fosteri*
At Risk-Recovering	Nil
At Risk-Relict	Nil
At Risk-Naturally uncommon	Nil
Not Threatened	Tuna/shortfin eel *Anguilla australis* Common smelt *Retropinna retropinna* Common bully *Gobiomorphus cotidianus* Redfin bully *Gobiomorphus huttoni* Upland bully *Gobiomorphus breviceps* (not diadromous) Black flounder *Rhombosolea retiaria*
Introduced and naturalised	Brown trout Rainbow trout Chinook salmon Perch

Source: Te Rōpū Matatau, based on data from NIWA. (2022). *Hydrology, water quality and ecology of the Lower Clutha,* Table 5-1.

[163] NIWA. (2022). *Hydrology, water quality and ecology of the lower Clutha,* at page 17

[164] NIWA. (2022). *Hydrology, water quality and ecology of the lower Clutha,* at page 18

The diversity of fish species recorded in the lower Mata-Au/Clutha River to date is not quite as diverse as that of nearby rivers. This may in part reflect the difficultly of sampling the main stem of the River but might also be due to the habitat that the River offers. Many native fish species are cryptic, edge-dwelling, and prefer shallow marginal habitats with slow flowing water. This type of habitat is largely absent in the lower Mata-Au/Clutha River. [165]

A report on the native fish of the lower Mata-Au/Clutha River concluded that the river generally provides relatively little suitable habitat for native fish, with more favourable habitat found in the cobble/boulder-bedded confluences of the tributaries with the Mata-Au/Clutha River. [166]

Four species of introduced fish have been recorded in the lower Mata-Au/Clutha River:

- Brown trout
- Rainbow trout
- Chinook salmon
- Perch

Perch are relatively unimportant as a sports fish, and rainbow trout are not common within the River. By contrast, brown trout occur throughout the lower river and constitute an important seasonal fishery. Chinook salmon are also an important sports fish.

The Mata-Au/Clutha River catchment is the most popular angling catchment in the Otago Fish & Game region. The section between Tuapeka Mouth and Balclutha is quite attractive to anglers as it has a medium gradient, wide open riffle and runs, and well-defined pools (especially when the river flows are less than 400m^3/s).

The Mata-Au/Clutha River is the most southerly of the recognised salmon rivers, and salmon fishing is concentrated near the mouth of the river, but also in the reach immediately downstream of the Roxburgh Dam. The construction of the Roxburgh Dam resulted in a decline of salmon numbers in the River, as there is relatively little spawning habitat within the lower River.

The Mata-Au/Clutha River also provides whitebait and eel fisheries. Shortfin eels are mainly located near the coast whereas longfin eels are present throughout the catchment but have been affected by the development of the hydro dams. There is now only a small remnant population of longfin females in the headwater lakes.

5.4.3 Potential impacts of the project on baseline characteristics

The abstraction of water from the Mata-Au/Clutha River and its subsequent discharge back into the River has the potential to impact aquatic habitats due to the rate of the discharge, differences in water temperature, suspended solids, turbidity, oxygen concentrations, and concentrations of chemically reduced ions including phosphorous, iron and manganese that may occur in the intervening period (i.e. when it is resident in Lake Onslow and/or the lower reservoir). Careful consideration to the operating regime of the project will therefore be required to minimise any resultant adverse effects of this discharge.

s 9(2)(i)

[redacted]

[165] NIWA. (2022). *Hydrology, water quality and ecology of the lower Clutha,* at page 19

[166] NIWA. (2022). *Hydrology, water quality and ecology of the lower Clutha,* at page 18

In addition, the operation of the proposed project will only commence the harvesting of water from the River when the flow is equal to or greater than s 9(2)(i) [redacted] This will ensure that the existing minimum flow that must be maintained at the Roxburgh Dam is respected.

The potential impacts of the proposed water harvesting rates from the Mata-Au/Clutha River on the ecological values of the River have not yet been able to be fully investigated but NIWA has observed that the situation of greatest extraction as a proportion of the flow in the River below the Roxburgh Dam is likely to have a 'non-trivial' impact on the flow duration curve of the lower river.[167] As noted above, taking water from the river at a rate of s 9(2)(i) [redacted] would only occur when flows in the river are s 9(2)(i) [redacted]

The abstraction of water from the Mata-Au/Clutha River, including from Lake Roxburgh, has the potential for fish loss through the operation of the project. To address that impact, the three lower intake options all include screening to prevent passage and entrainment of fish. Fish screening specifications incorporated into the design to date are based on current guidelines, and the specific species present in the various affected waterbodies. Further details on these specifications is provided in **Chapter 6: Facility Design of the Feasibility Study**[168]**.** This is a matter that will require ongoing discussions with regulators such as Otago Regional Council, and other stakeholders such as mana whenua and Fish & Game.

5.4.4 Options to address project impacts

As set out above, mitigating impacts on the Mata-Au/Clutha River is likely to be primarily achieved via the operating regime and adherence to a minimum flow requirement in the River. As signalled in Section 5.2.3 of this Chapter, this could be supported by monitoring the conditions such as temperature, water quality and oxygen levels in Lake Onslow in order to inform when, and from where in the water column, water might be discharged down into the lower reservoir (and thereafter to the Mata-Au/Clutha River depending on the residence time of water in the lower reservoir). Further work is required to determine how such monitoring might be able to be implemented, particularly in a lake that experiences high levels of water level fluctuation. This includes determining the best structure to mount the monitoring sensors on (e.g. a fixed tower, a buoy, or a mix of fixed height-above-bed and floating sensors).[169]

It is proposed that a graduated abstraction rate which maintains the current consented minimum flow would be employed to ensure that the river related values including ecology, recreation and amenity protected by the current consented minimum flow in the Mata-Au/Clutha River (250m^3/s) are maintained at all times. It is likely that a maximum ramping rate for discharge into the receiving waters would also be required to mitigate against adverse effects from high volumes of water being returned to the river (effects on habitat, erosion and the like).

NIWA notes that the impact of pumping at, and just above the minimum flow threshold in the Mata-Au/Clutha River below the dam could be moderated by intermittent pumping, which should be considered in future design work.[170] Downstream water takes, cultural values, and ecosystem health, including any impact of receiving water quality, are key factors that would need to be factored in to determining the most appropriate flow regime.

There is also the potential for in-river structures such as groynes and sills to be constructed within the Mata-Au/Clutha River to maintain the continued operation of the proposed offtakes at s 9(2)(i) [redacted]. Such in-river structures have the potential to modify the river

[167] NIWA, (2022). *Addendum to Lake Onslow baseline reports*, page 9

[168]

[169] NIWA. (2022). *Addendum to Lake Onslow baseline reports,* at page 11

[170] NIWA. (2022). *Addendum to Lake Onslow baseline reports,* at page 9

environment to better suit weed bed development (due to reductions in water velocity and subsequent accumulation of substrate). The risk of entraining weeds that may establish as a result of such structures being present in the river can be reduced by siting the intake structures at depths greater than 5-6m deep.[171]

Mitigation options that would reduce the risk of *Lagarosiphon major* in the lower reservoir and ultimately transferring to the receiving waters of the river include:

- Steeply sloped reservoir excavation/bund sites
- Rip rap on excavated batter faces limiting suitable substrate for establishment of *Lagarosiphon major*
- Maintaining a higher water depth than the habitat range for aquatic species for extended periods (greater than three to six months)
- Rapid water level fluctuations over the full operating range; and
- Regular drawdown and drying of the reservoirs.

These same mitigation options are not available with direct abstraction from Lake Roxburgh because it is an existing reservoir.

5.5 Recommended future actions

If the project progresses, it is recommended that the following work is undertaken to extend understanding of the baseline freshwater values within the project area, continue to build an understanding of the ways in which the project may impact those values, and identify options for addressing those impacts:

- Improve the understanding of the baseline characteristics of the Mata-Au/Clutha River, including the existing consented takes authorised within the catchment and the ecological values of the river.
- Further investigations to better inform what the likely sediment loading will be in Lake Onslow, both as a result of introducing pumped water; but also as a result of the inundation of soils and vegetation and from the erosion of the littoral zone due to water level fluctuations.
- Better understand the soil and vegetation that would be inundated at Lake Onslow to assist with predicting the effects on water quality of the new upper reservoir.
- Rerunning NIWA's existing one dimensional hydrodynamic model to reflect preliminary operating regimes and to consider multiple intake levels, shifting to a three dimensional model in the longer term.
- Additional work to build a more complete understanding of the food sources for trout in Lake Onslow.
- Further field survey work to determine the full extent and population size of the Teviot flathead galaxias
- Field survey work to confirm the presence of kōura within Lake Onslow.
- s 9(2)(i) [redacted]
- Site specific assessments for the various mitigation and offsetting opportunities that have been identified to determine their suitability.

[171] NIWA. (2022). *Addendum to Lake Onslow baseline reports,* at page 13

- Further work to understand the impacts of the proposed scheme on the Mata-Au/Clutha River, including those arising from the abstraction of water from the River, and those that will arise from the discharge of water back into the River.

5.6 Key concepts

This section provides an explanation of some of the important concepts that have been referred to in the scientific information used to inform this Chapter.

5.6.1 Hydrology

Hydrology deals with the distribution and movement of water, including the impact of human activity on these conditions. It relates to the flows and levels of water in rivers and streams, and the varying levels of water in lakes and wetlands.

The amount of water in waterbodies also contributes to the ecosystem health of that waterbody. Managing the ecosystem health of waterbodies is of high importance as signalled in the NPS-F.[172]

This chapter provides details on the hydrology of the various waterbodies that will be affected by the proposed scheme; the extent to which the hydrological characteristics might be impacted by the proposed scheme; and any options that are available to address adverse impacts.

One component of hydrology that is of particular interest to understand the potential impacts of the proposed scheme is 'residence time'. This is an estimate of the amount of time that water spends in a lake (or a reservoir). The residence time of a lake or reservoir can be used to estimate the amount of phosphorous and nitrogen that might be retained within the waterbody, which then has implications on the overall water quality of the lake or reservoir. Residence time may also influence the time available for the settlement of suspended solids, which can influence water clarity.

5.6.2 Stream orders

Streams are sometimes classified into a series of 'orders' which rates each stream segment according to its position in the catchment, and the number of streams that flow into it. A first order stream has no tributaries, whereas a second order stream has at least two first order tributaries. A third order stream must have at least two second order tributaries.[173]

5.6.3 Hydrodynamics

In the case of this Chapter, hydrodynamics relates to the way in which water (particularly in Lake Onslow and the proposed lower reservoirs) is currently influenced by energy sources external to the water body (e.g. heat from the sun and wind). Of particular interest from a hydrodynamics perspective is the extent to which lakes stratify (separate into layers of water with different temperatures and oxygen levels).

Stratification is important to understand because long periods of stratification can result in low levels of dissolved oxygen in the lower levels of water in the waterbody. This effect can adversely affect fish health, and the release of nutrients and greenhouse gases from sediments in a lake. As the lake remixes, nutrients can be transported upwards, which can lead to algal blooms. [174]

---

[172] Ecosystem health is one of the four compulsory values that must be managed in respect of all fresh water

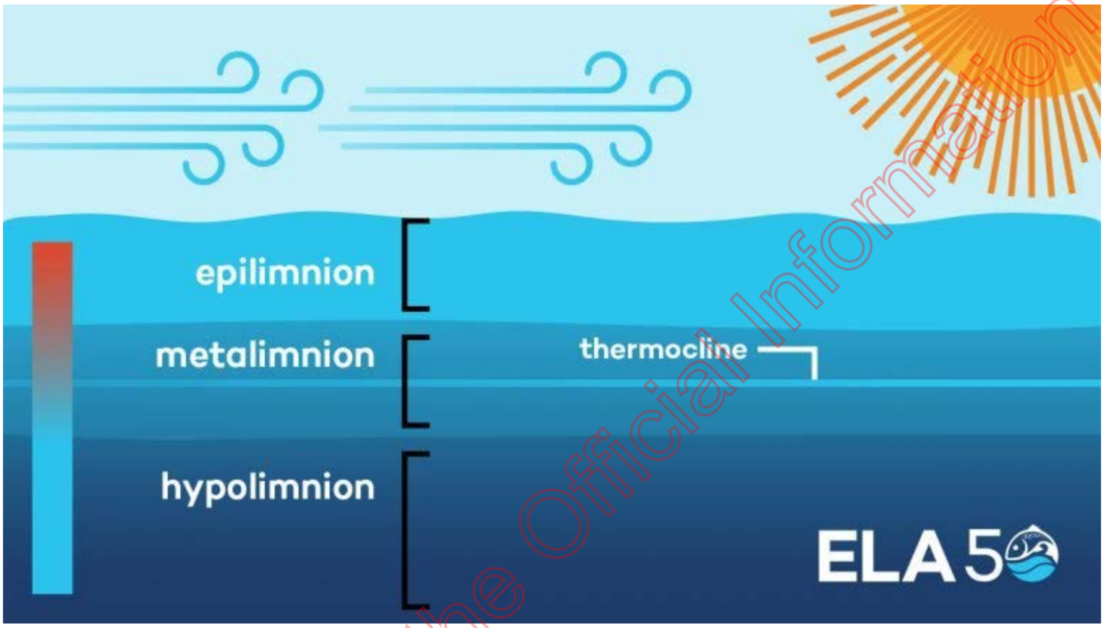
[173] LAWA. (2022). Stream orders, www.lawa.org.nz accessed 23 August 2022

[174] NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology*, at page 39

An illustration of the concept of stratification is provided in Figure 5.17 below. The epilimnion is the uppermost layer in a stratified lake, is the layer of water that is the warmest, and has the highest levels of dissolved oxygen. The deepest, coldest layer is the hypolimnion. This layer often remains around 4°C as this is the temperature at which water is the most dense. The hypolimnion contains the lowest amount of dissolved oxygen.

The middle layer (metalimnion) is the transition zone of water between the uppermost and lowest layers. The point of greatest temperature difference (and therefore density difference) is the thermocline.

Figure 5.17: Stratification



Source: International Institute for Sustainable Development. (2022). How and Why Lakes Stratify and Turn Owner: We explain the science behind the phenomena. www.iisd.org.nz

5.6.4 Water quality

Water quality is one of the attributes that contributes to the ecosystem health of waterbodies. Managing the ecosystem health of waterbodies is of high importance as signalled in the NPS-F. It is also important from the perspective of human contact with waterbodies, and in relation to other values that might be associated with waterbodies such as drinking water supply and the use of water for irrigation.

Water quality is influenced by a range of characteristics including the level of dissolved oxygen that is present; levels of suspended sediments in the water body, and the levels of substances that signal the level of toxicity of the water such as ammonia, nitrogen, phosphorous, and nitrates.

The NPS-F sets national bottom lines in relation to a range of the attributes that relate to water quality. Some of these attributes are specifically relevant to rivers, and others are identified in the NPS-F as being applicable to lakes. These attributes are summarised in Table 5.6 below.

Table 5.6: Overview of NPS-F attributes that relate to water quality

Attribute	Lakes	Rivers	NPS-F national bottom line?
Ammonia (toxicity)	Y	Y	Y
Dissolved oxygen	-	Y	Y
Dissolved reactive phosphorus	-	Y	N
Lake-bottom dissolved oxygen	Y	-	Y
Mid-hypolimnetic dissolved oxygen	Y (seasonally stratifying lakes)	-	Y
Nitrate (toxicity)	-	Y	Y
Suspended fine sediment (clarity)	-	Y	Y
Total nitrogen	Y	-	Y
Total phosphorous	Y	-	Y

Source: Te Rōpū Matatau

Other attributes that are commonly used to assist in describing water quality characteristics include:

- Total suspended solids
- Light conditions
- Trophic state

5.6.5 Trophic state

The trophic state of a lake refers to its nutrient status and levels of algal growth. The TLI score is commonly used in New Zealand to describe the levels of nutrients in a lake and its impacts. TLI scores are based on measurements of four parameters: water clarity, chlorophyll content, total phosphorous and total nitrogen. The TLI and their characteristics are summarised in Table 5.7.

Table 5.7: TLI scores

TLI score	Trophic term	Nutrient concentration	Algal production	Dissolved oxygen	Water clarity
0 – 2	Microtrophic	Very low	Very low	Very high	Very high
>2 – 3	Oligotrophic				
>3 – 4	Mesotrophic				
>4 – 5	Eutrophic				
>5	Supertrophic	Very high	Very high	Very low	Very low

Source: Te Rōpū Matatau, information sourced from NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology,* at page 58

The levels of nitrogen and phosphorous are measured to inform the concentration of nutrient levels in a lake, and levels of phytoplankton indicate how much algal production is occurring in a lake.

5.6.6 Periphyton, phytoplankton and macrophytes

The presence of aquatic plants and plant-like organisms such as algae in a waterbody can be an indicator of the health of a water body, depending on the species and abundance present.

Periphyton are organisms that live attached to underwater surfaces, whereas phytoplankton are organisms that live in the water, unattached to surfaces. Periphyton is the slime and algae found on the beds of streams and rivers. It is essential for the function of healthy ecosystems, but when it proliferates it can become a nuisance.[175]

Macrophytes are rooted plants that grow on the bed of lakes and rivers. They include plant species that either live wholly underwater or occupy the water-land interface.

The NPS-F includes a series of attributes that help to describe the aquatic life within a waterbody as an indicator of its ecosystem health. In the case of rivers, periphyton is measured as an indicator of the levels of nutrient enrichment in the river, and the extent to which blooms of periphyton might be altering the natural flow regime or habitat of the river.

In the case of lakes, the presence of phytoplankton, submerged native plant species and submerged invasive plant species are measured to help describe the aquatic life within the lake. Similar to periphyton in rivers, the presence of phytoplankton in lakes is measured as an indicator of the levels of nutrient enrichment in the lake. Decaying biomass at the end of a growth cycle can deplete the oxygen and habitat available for native aquatic plant species and other species that live in the lake.

5.6.7 Macroinvertebrates

Macroinvertebrates are another indicator of the ecosystem health of a water body. Macroinvertebrates are animals that lack a backbone, but which are large enough to be seen by the naked eye. Macroinvertebrates vary widely in their tolerances to both physical and chemical conditions and are thus used regularly in biomonitoring as an indicator of stream health. The MCI and the Quantitative Macroinvertebrate Community Index (QMCI), which are calculated using individual tolerance scores for species present in a sample, indicate the extent of organic pollution or nutrient enrichment of a waterbody.

The NPS-F includes an attribute that relates to these indexes and sets national bottom lines in relation to this attribute.

5.6.8 Fish

The waterbodies that will be utilised by, and affected by, the proposed scheme variously provide habitat to a range of indigenous and exotic fish species. This includes the only global habitat of the Threatened-Nationally Critical Teviot flathead galaxias which lives in a number of tributaries to Lake Onslow and the Te Awa Makarara/Teviot River.

5.6.9 Existing authorisations and uses of water

There is a range of existing authorisations in place for various uses of water from the waterbodies that will be affected by the proposed scheme, and an overview of these authorisations is provided for each of the waterbodies. Examples of such authorisations include damming rivers for hydro-electric generation; and taking water for the purposes of irrigation and drinking water. The 'picture' of these existing authorisations is a dynamic one and is influenced not only by their rolling expiry and potential renewal, but also by the changing statutory landscape as it applies to freshwater management.

[175] NIWA. (2010). *New Zealand Periphyton Guideline: Detecting, Monitoring and Managing Enrichment of Streams,* at page 10

6 Groundwater

Groundwater is used as an important resource in Otago for drinking, frost-protection, irrigation, industry and stock water supply. This chapter outlines existing baseline information on groundwater quality and quantity in the project area and considers any potential impacts the construction and/or operation of the project may have on this resource.

Geotechnical site investigations undertaken by Te Rōpū Matatau have included some groundwater testing and modelling of the upper reservoir for the purpose of quantifying seepage from the reservoir (at the current level) and proposed fill levels. Testing and sampling has also occurred in the Teviot Valley.

A detailed description of the groundwater profile is explained in Geological, Geotechnical and Hydrogeological Data Report (NZBLO-TRM-01A-10-RPT-GEO-000051-A, 2021) prepared by Te Rōpū Matatau. Information on baseline groundwater quality has been obtained from this work, together with information available in the Regional Plan: Water for Otago and the State of the Environment Groundwater Quality in Otago (2021) published by the Otago Regional Council.

6.1 Groundwater characteristics

Groundwater is complex and inherently related to both in-situ geological conditions and geomorphological domains. Given the project is situated across a large geological area (both in terms of area and with proposed infrastructure at depth), the characteristics of groundwater across the project area can be expected to vary based on the underlying geology and geomorphic terrains.

6.1.1 Aquifers, Groundwater Protection Zones and Freshwater Management Units

The Regional Plan: Water for Otago identifies two aquifers within the project area:

- Roxburgh Basin Aquifer
- Ettrick Basin Aquifer

As shown on Figure 6.1, these are located adjacent to the Mata-Au/Clutha River, near Roxburgh and Ettrick respectively. Both aquifers are identified as Groundwater Protection Zone A which applies to land over aquifers considered to be at high risk of leachate contamination.

These aquifers are vulnerable to activities likely to generate leachate, including the discharge of water or contaminants to land or directly into groundwater and the excavation of land (which may remove the protective soil mantle or impervious stratum and further increases the vulnerability of the aquifer)[176].

There are water take restriction areas within these aquifers as identifed in Map D3 of the Regional Plan: Water for Otago. Groundwater take restrictions apply if the aquifer reaches a certain level and this is managed by either a reduction of the percentage of take permitted, or through a water allocation committee. No underlying groundwater aquifer is identified at Lake Onslow itself.[177]

[176] Otago Regional Council. (2004). *Regional Plan: Water for Otago*, Policy 9.4.18
[177] Otago Regional Council. (2004). *Regional Plan: Water for Otago*, Schedule 4B.1

s 9(2)(i)

The NPS-F requires FMU to be set at the appropriate scale for managing water, setting objectives and limits. The project area is within the Clutha/Mata-au FMU, which is the largest FMU in Otago. The project area is within the Roxburgh Rohe (sub-area) within this unit.

6.1.2 Groundwater quality

Groundwater monitoring occurs across the region through bores, and although not geographically evenly distributed, this does provide an understanding of groundwater quality.

The State of the Environment Groundwater Quality in Otago (2021) summarises groundwater quality for the Lower Clutha Rohe as having significant water quality issues with elevated E. coli, nitrate concentrations and dissolved reactive phosphorus (DRP). The widespread use of artificial paddock drainage together with shallow water tables have been identified as contributors to these water quality issues.

There is one groundwater monitoring bore in the Roxburgh basin which shows that there were no exceedances of E. coli or dissolved arsenic maximum acceptable value (MAV) and that groundwater nitrate concentrations are within the Drinking Water Standards for New Zealand (DWSNZ). However, when results were assessed against the Regional Water Plan and the NPS-F National Objectives Framework (NOF), they indicate poorer groundwater quality results, which may be caused by potential issues with surface water quality, particularly regarding nitrates and DRP[178].

The Ettrick basin groundwater quality is monitored by two bores which show exceedances in E. coli, and high nitrate concentrations, but again below the DWSNZ MAV. Specifically, dissolved arsenic and ammonia concentrations do not exceed the MAV. When compared to the Regional Water Plan standards, there was a high degree of non-compliance with limits of nitrate and DRP exceeded. Compared to the NPS-F NOF, the nitrate concentrations would likely impact the growth of multiple species.

In addition to this, Te Rōpū Matatau has undertaken groundwater monitoring near Lake Onslow. The results of this monitoring are outlined in the Ground Water Quality Technical Memorandum (Te Rōpū Matatau, NZBLO-TRM-01B-010-TMN-GEO-000464-A, 2022), and are summarised as:

- Groundwater has higher dissolved solids concentrations than surface water and reflects the dissolution of carbonate minerals present in local geology. This is evident as slightly alkaline pH and dominance of alkalinity over other constituents.
- Sulphate concentrations are low, but elevated relative to surface water. This is expected to be a consequence of the ongoing oxidation of sulphide minerals in unsaturated soil/rock. The alkalinity present in groundwater appears to be sufficient to buffer the acidity generated from this oxidation.
- Dissolved trace elements measured at concentrations above laboratory detection levels include nickel, zinc, manganese and iron. Total concentrations for nickel and zinc, reflective of sediment in groundwater samples, suggest occurrence of these metals in aquifer materials. The concentrations of dissolved zinc and nickel detected in groundwater are elevated relative to surface water but are not greater than the relevant surface water quality criteria.
- Trace element concentrations such as iron and manganese were greatest in the groundwater sample obtained from the deeper alluvium when compared to the other samples. This sample also exhibited low concentrations of arsenic, lead, copper and chromium. The occurrence of elevated iron and manganese, and detection of other trace

[178] Otago Regional Council. (2021). *State of the Environment Report. Groundwater Quality in Otago-March 2021*.

elements at this location, suggests the prevalence of anaerobic conditions within groundwater are likely present in deeper alluvium. This is further supported by the occurrence of inorganic nitrogen in ammoniacal nitrogen form, rather than oxidised nitrogen (such as nitrate).

6.2 Impact of project on the baseline characteristics

The proposed offtake options at s 9(2)(i) [redacted] are not located within the Roxburgh or Ettrick basin aquifers. s 9(2)(i) [redacted]

As such, the s 9(2)(i) [redacted] option might be expected to need the greatest management of impacts on groundwater. Regardless, across the whole project area, the project has the potential to impact the quantity and quality of groundwater, both during construction and operation of the project as set out below.

6.2.1 Construction

During construction, the following impacts to groundwater are possible:

- The excavation of material for the intake, tunnel and dam construction could intercept groundwater. This could alter the existing hydrological regime.
- Change to the hydrological regime could adversely affect ecology (such as disrupting the source for spring/ground fed tributaries or wetlands, which would indirectly affect habitat for fish species). The DOC Assessment of Conservation Values Report (2022) identified that the tributaries at Lake Onslow are reliant on groundwater discharge from wetlands[179].
- The abstraction of groundwater could impact the quantity of groundwater available for existing groundwater takes (through bore interference), including community water supplies and other aquifer users.
- The disturbance of soil and interception of groundwater could result in contamination of groundwater.
- Run-off and discharges from construction could result in contamination of groundwater (sources could include hazardous substances from construction vehicles and equipment).

6.2.2 Operation

- Alteration of the hydrogeological regime through the increased size of Lake Onslow, the operational fluctuations in Lake levels, the takes and discharges to the lower reservoir and the Mata-Au/Clutha River.
- Alteration of the hydrological regime may affect the hydrological functioning of wetlands and surface waterbodies.
- The ongoing use and storage of hazardous substances near the sensitive Roxburgh and Ettrick basin aquifers could increase the risk of contamination of these aquifers.

6.3 Options to address impacts

During construction, a Construction Environmental Management Plan would likely be required and would include measures to safely store and handle hazardous substances to avoid spills or the release of substances which could potentially enter and affect groundwater. The impact of underground excavations on the groundwater system will need to be assessed. Where potential issues are identified construction methods can be employed to avoid the significant drawdown of groundwater. However, these types of effects are likely to be limited to near

[179] Department of Conservation. (2022). *Assessment of Conservation Values at Lake Onslow*

surface excavation (portals, shafts etc). It is unlikely that tunnels at great depth (>100m) will have a significant impact on near surface groundwater systems.

6.4 Information gaps and risks to decision-making

Information on groundwater collated to date is based on material collected as part of investigations directed towards the development of project design and associated optioneering. Further monitoring and investigation is needed to fully inform the groundwater profile.

6.5 Recommended future actions

If the project proceeds, it is recommended that the following actions are taken to improve the understanding of potential impacts on groundwater:

- Further monitoring and investigation to determine the groundwater profile where existing data is not available.
- Further investigation into the hydraulic connection between groundwater and other waterbodies (including tributaries, wetlands and rivers).
- An assessment of the potential impacts to groundwater as a result of construction and operation of the project.

7 Indigenous biodiversity

The potential impacts that the project would have on indigenous biodiversity are significant due to the scale of the proposed inundation of land, the types of habitats and species that are present in the impacted areas, and the conservation status (or value) of some of those species. As set out in **Chapter 18: Legislative context**, protecting areas of significant indigenous vegetation and significant habitats of indigenous fauna is a matter of national importance within the RMA.

This chapter describes the baseline characteristics, potential impacts, and opportunities for mitigation/offsetting in respect of each of the following themes:

- Terrestrial habitats
- Terrestrial plants and vegetation
- Terrestrial invertebrates
- Herpetofauna
- Avifauna
- Bats

This chapter focusses on addressing terrestrial indigenous biodiversity, with aquatic ecology (including indigenous biodiversity) being addressed in **Chapter 5: Freshwater**. It is acknowledged that some habitats comprise both freshwater and terrestrial aspects, and that some species have lifecycles that occur both within freshwater and on land – these nuances will be identified as appropriate both in this Chapter and in **Chapter 5: Freshwater**.

7.1 Basis of findings to date

As described in the Introduction, due to project phasing, timeframes, and land access limitations, there has been limited and disparate opportunity to undertake field assessments of ecological values in the various geographic locations that the project will be located within. In broad terms, some field work has been able to be undertaken in the area surrounding Lake Onslow and has informed the baseline characteristics described in this chapter, whereas the data that has informed the baseline characteristics at each of the three intake options has been predominantly desktop based.

Due to the limited amount of information available regarding the precise location of tunnel portals and other surface level facilities, neither desktop data nor field survey work is yet available to identify potential ecological values in these locations.

7.2 Key principles and concepts

The work outlined in this chapter has been informed by the following key principles and concepts:

- Ecological districts
- Threatened environment classification
- New Zealand Threat Classification System
- Protected areas

7.2.1 Ecological districts

An 'ecological district' is a geographic area that has a characteristic landscape and a range of biological communities. Each ecological district is a unique unit with its own distinctive general pattern of ecosystems and special features. Aotearoa New Zealand has been categorised into a number of ecological districts. Ecological districts within an ecological region combine to form a region with its own broad character, differing in many ways from those of its neighbouring regions.[180]

The project is located across two ecological districts. The majority of the proposed inundation area and the proposed dam, as well as the proposed offtake s 9(2)(i) are located in the Waipori Ecological District (within the Lammerlaw Ecological Region). The northernmost extent of the proposed inundation area and the Lake Roxburgh offtake are located in the Manorburn Ecological District (within the Central Otago Ecological Region).

[180] McEwen, M. (1987). *Ecological Regions and Districts of New Zealand*. NZ Biological Resources Centre, published by the Department of Conservation.

s 9(2)(i)

[redacted]

7.2.2 Threatened environment classification

The Threatened Environment Classification was developed by Landcare Research to help identify places in Aotearoa New Zealand in which the terrestrial ecosystem, habitat and community types are both much reduced *and* poorly protected nationally.[181] Threatened environments are those environments in which much of the original indigenous cover has been cleared and/or low proportions of land is legally protected for natural heritage management.

The Threatened Environment Classification can be used to provide information on the loss and protection context of indigenous biodiversity components identified on the ground. In conjunction with site surveys, it can help to identify places that are priorities for formal protection against clearance and/or incompatible land uses, and where restoration could be prioritised.

Table 7.1 below describes the six threat categories used in the Threatened Environment Classification.

Table 7.1: Threatened environment classifications

Category	Extent of indigenous cover remaining	Level of protection
1	<10% indigenous cover left	N/A
2	10-20% indigenous cover left	N/A
3	20-30% indigenous cover left	N/A
4	>30% indigenous cover left	<10% protected
5	>30% indigenous cover left	10-20% protected
6	>30% indigenous cover left	>20% protected

Environments that are within Threat Category 1 are most at risk due to the limited extent of original cover remaining. Environments within threat categories 4-6 all have more than 30% of indigenous cover remaining, with varying levels of formal protection.

The land around Lake Onslow is generally within Categories 4 and 6. Land within the vicinity of the s 9(2)(i) offtake option is largely within Category 3; and land at s 9(2)(i) and s 9(2)(i) is in Category 1 (see Figure7.2).

[181] Leathwick, J R, F Morgan, G Wilson, D Rutledge, M McLeod, and K Johnston. (2002). *Land Environments of New Zealand: A Technical Guide*. Wellington: Landcare Research, Ministry for the Environment.

s 9(2)(i)

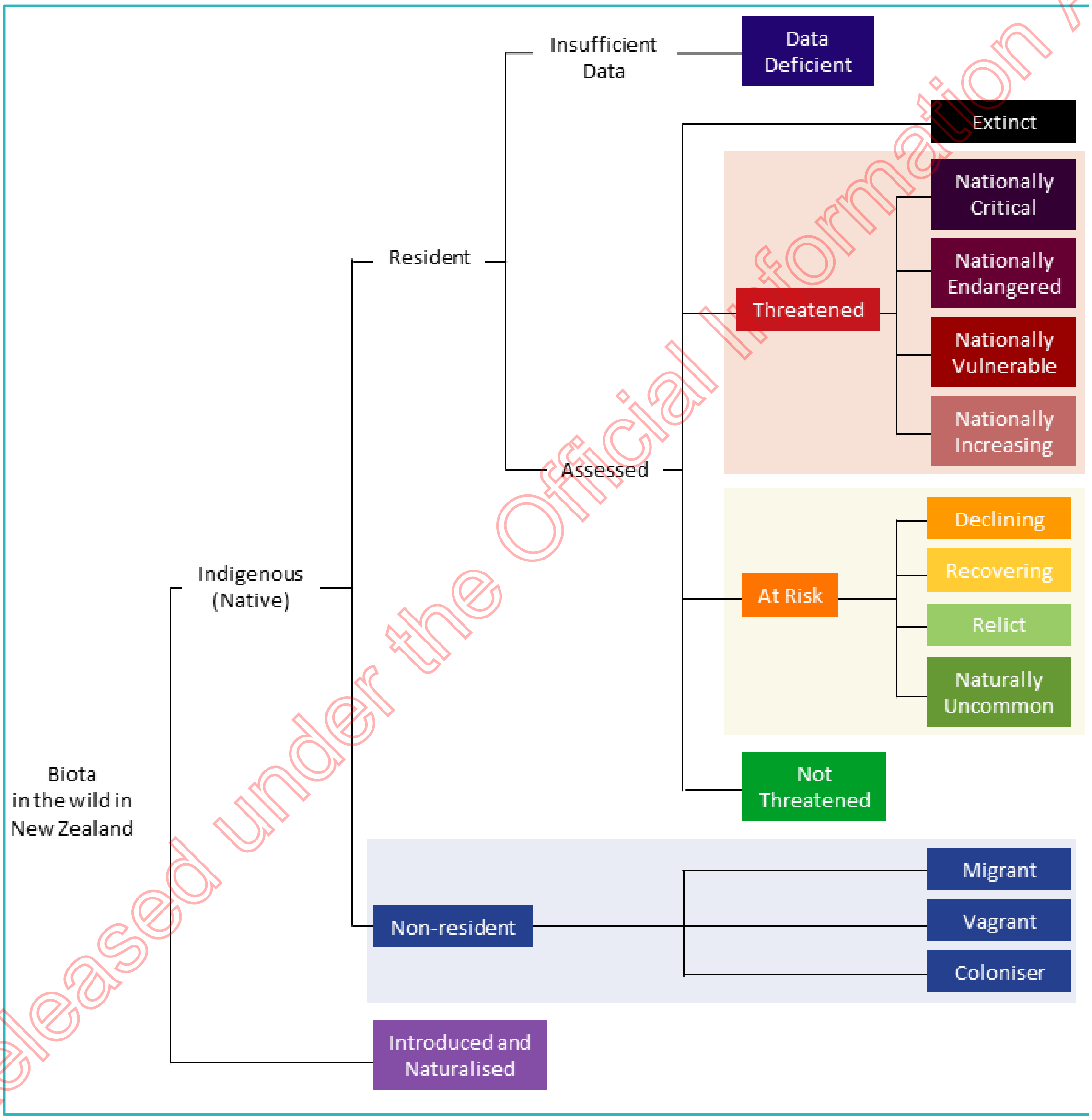
[redacted]

7.2.3 New Zealand Threat Classification System (NZTCS)

The NZTCS is used to assess the conservation status (threat of extinction) of Aotearoa New Zealand's taxa (species, subspecies, varieties and forma) and is administered by DOC.[182] The list is not exhaustive and is progressively added to as new species or groups of species are added to the system or as threats are being re-assessed. The NZTCS includes the conservation status of a range of species including (but not limited to) birds, plants, fish, invertebrates and lizards.

The NZTCS categorises taxa into the categories illustrated in Figure 7.3 below.

Figure 7.3: New Zealand Threat Classification System categories



Source: www.nztcs.org.nz

[182] Townsend, A. J., P. J. de Lange, Clinton A. J. Duffy, Colin M. Miskelly, Janice Molloy, and David A. Norton. (2008). *New Zealand Threat Classification System Manual*. Wellington: Department of Conservation.

For context, well known examples of Nationally Critical species included the Maui dolphin and the long tailed bat; Nationally Endangered species include Hoiho and the Kea; Nationally Vulnerable species include the South Island Takahe and At Risk Declining is the category of the New Zealand pipit.

Based on the work undertaken to date, the presence of Threatened-Nationally Critical species has been confirmed within the proposed inundation area, as well as species in the other Threatened and At Risk categories. Further information on these species is outlined later in this chapter.

While limited work has been undertaken within the areas that would be affected by the proposed offtake and the surface level works associated with the various tunnels and other above-ground facilities, there is potential for additional At Risk and Threatened species to be found in these areas. By way of example, desktop data indicates that there is a sizeable area of the Threatened-Nationally Vulnerable plant species makahikātoa at the proposed Lake Roxburgh offtake location.

7.2.4 Protected areas

The Central Otago District Plan and the Regional Plan: Water both identify areas which seek to protect indigenous biodiversity. The Central Otago District Plan identifies 'Areas of Significant Natural Value' which are located on the planning maps and described in Schedule 19.6.1 of the District Plan. It also identifies a series of 'Additional Wetlands' which are shown on the planning maps and described in Schedule 19.6A.

The Regional Plan: Water identifies 'Regionally Significant Wetlands' which are shown on the planning maps and described in Schedule 9 to the Plan.

Table 7.2 summarises the protected areas that are currently identified within the project area, noting that they are all wetlands.

Table 7.2: Summary of protected areas within the project area

Name	Protected area type	Identifying document	Potentially affected by project?
Fortification Creek Wetland	Significant Natural Area	Central Otago District Plan	Yes – inundation at both 3TWh and 5TWh full supply levels
	Regionally Significant Wetland	Regional Plan: Water	
Middle Swamp Wetland	Regionally Significant Wetland	Regional Plan: Water	Yes – inundation at both 3TWh and 5TWh full supply levels
West Boundary Creek Swamp	Additional Wetland	Central Otago District Plan	Yes – inundation at both 3TWh and 5TWh full supply levels
s 9(2)(i) [redacted]	[redacted]	[redacted]	
s 9(2)(i) [redacted]	Regionally Significant Wetland	Regional Plan: Water	
	Additional Wetland	Central Otago District Plan	No
	Additional Wetland	Central Otago District Plan	
	Significant Wetland	Regional Plan: Water	

Name	Protected area type	Identifying document	Potentially affected by project?
s 9(2)(i) [redacted]	s 9(2)(i) [redacted]	[redacted]	Potentially – located on the true left bank of the Mata-Au/Clutha River in the vicinity of the s 9(2)(i) [redacted] offtake location. Further work needed to determine whether works in the Mata-Au/Clutha River would have any impacts on this wetland complex.
	Significant Wetland	Regional Plan: Water	
	Additional Wetland	Central Otago District Plan	s 9(2)(i) [redacted] offtake location. Potential to be affected by roading upgrades or other construction works in this location.
	Significant Wetland	Regional Plan: Water	
	Additional Wetland	Central Otago District Plan	Potential to be affected by roading upgrades or other construction works in this location.
	Significant Wetland	Regional Plan: Water	

Source: Te Rōpū Matatau

Further details about the above wetlands and the potential impacts of the project on these wetlands is addressed in **Chapter 5: Freshwater**.

7.3 Lake Onslow and surrounds

The following summarises the baseline characteristics, potential impacts and options to address impacts for indigenous biodiversity in and around Lake Onslow.

7.3.1 Terrestrial habitats

7.3.1.1 Baseline characteristics

Wildlands Consultants Limited (Wildlands) undertook desktop studies for the project in December 2020 which focused on summarising the known botanical, lizard, and wetland features and values in the vicinity of Lake Onslow, the Manorburn Reservoir, and the Greenland Reservoir.[183]

Building on the desktop analysis, Wildlands undertook field survey work in December 2021 over a period of five days on some of the land that would be affected by the proposed upper reservoir. The findings of this field survey work informed Wildlands' Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago (July 2022) (attached as **Appendix E.2, Volume Two**).

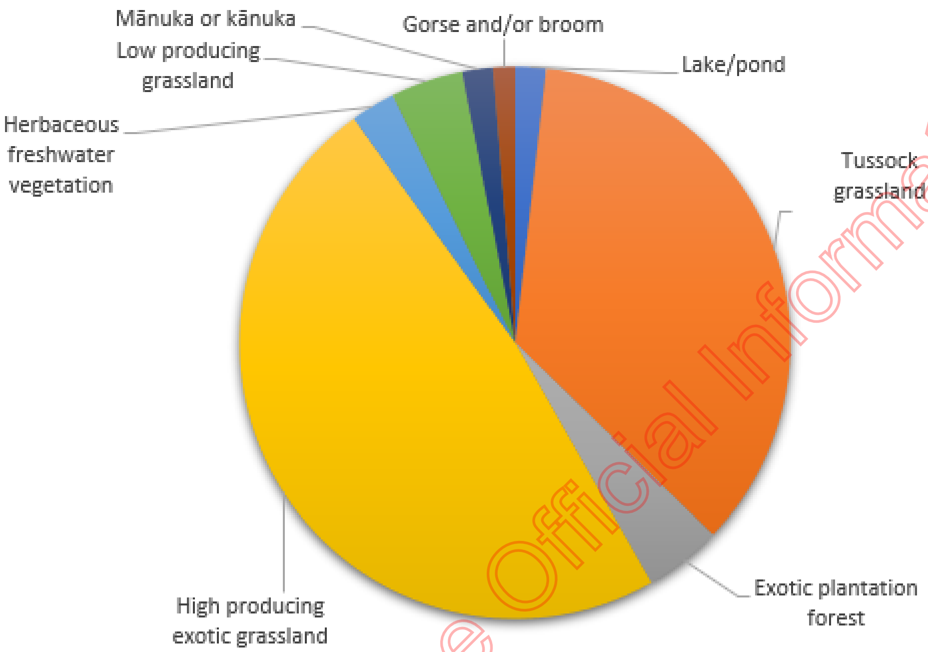
[183] Wildlands Consultants Limited. (2020). *Desktop Assessment of Vegetation and Botanical Values in the Vicinity of the Proposed Lake Onslow Pumped Hydro Storage Project, Otago.*

Wildlands Consultants Limited. (2020). *Desktop Assessment of Lizard Species at Lake Onslow, The Manorburn Reservoir, and the Greenland Reservoir in the Vicinity of the Proposed Lake Onslow Pumped Hydro Storage Project, Otago.*

Ecological context

The proposed inundation area is predominantly located within the Waipori Ecological District, with the northern part of the proposed upper reservoir located in the Manorburn Ecological District. The Waipori Ecological District is characterised as an upland schist plateau reaching up to 1211m above sea level, with a cool dry to moist climate.[184] The types of vegetation cover within the Waipori Ecological District are illustrated in Figure 7.4 below. As can be seen, it is dominated by high producing exotic grassland and tussock grassland (approx. 16,000ha in total).

Figure 7.4: Types of vegetation cover in the Waipori Ecological District



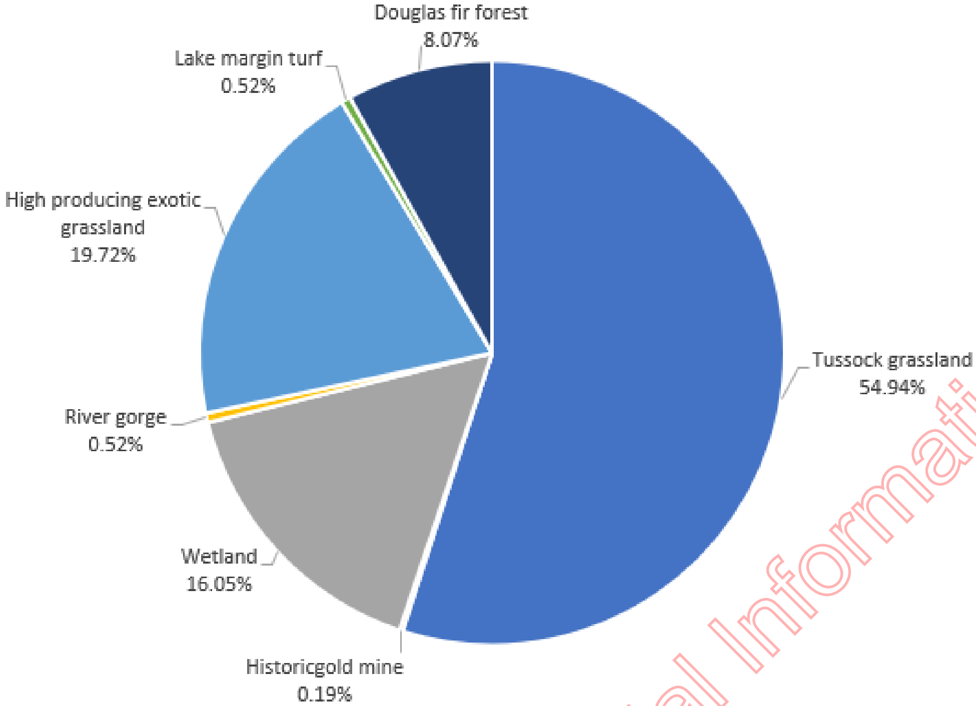
Source: Te Rōpū Matatau, based on data provided by Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*

Vegetation and habitat types

Vegetation and habitat types within the properties surveyed by Wildlands in the inundation area can be classified into 10 broad ecosystem types as illustrated in Figure 7.5 below.

[184] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at lake Onslow and Adjacent Vegetation and Habitats, Central Otago,* at page 11

Figure 7.5: Vegetation and habitat types within surveyed properties within inundation area



Source: Te Rōpū Matatau, based on data provided by Wildlands Consultants Limited. (2022). Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago

The dominant ecosystem types within the properties surveyed in the inundation area are tussock grassland, high producing exotic grassland, and wetlands. These ecosystem types are also present in the un-surveyed parts of the inundation area, but without further field survey it is not possible to ascertain the overall proportions of these ecosystem types within the entire inundation area.

Tussock grasslands have significant connectivity value and provide habitat for a range of indigenous species, notably several endemic moth species and the Burgan skink (Nationally Threatened).[185]

Lake Onslow is one of only a few large reservoirs in the Otago uplands with complex shorelines providing habitat for a diverse range of wading birds. The site is also a regionally important moult site for paradise shelduck, a species endemic to Aotearoa New Zealand.[186]

Wetlands are a significant habitat within the proposed inundation area (see Table 7.2 above). The largest of these is the Fortification Creek wetland complex, which is noted as a '**significant natural area'** in the Central Otago District Plan, identified within the Regional Plan: Water as having '**regional significance'**, and assessed in the Wildlands Report as having '**national significance'**, based on its size, intactness, range of hydrological variation and diversity of plaint communities. In Wildland's assessment, this wetland complex is the 'ecosystem of greatest ecological value within the Lake Onslow area'.

[185] Department of Conservation. (2022). *NZ Battery Project – Lake Onslow Option: Assessment of Conservation Values at Lake Onslow,* at page 31-32

[186] Department of Conservation. (2022). *NZ Battery Project – Lake Onslow Option: Assessment of Conservation Values at Lake Onslow*, at page 65

Further to the west of the Lake, Boundary Creek Fen and Middle Swamp wetlands are also identified in the Regional Plan: Water as having '**regional significance'** for their high degree of natural character.

Further detail on these values and those of the Fortification Creek wetland complex are set out in **Chapter 5: Freshwater**.

7.3.1.2 Impacts

The project would result in the inundation of Lake Onslow, certain lengths of its tributaries, and the land around it. Due to the extent of the proposed upper reservoir (for both the 3TWh and 5TWh options) and the likely operating range, the inundation would result in total loss of the terrestrial habitats within the inundation area and the dam footprint. The loss of these habitats would have flow-on effects on the various taxa that live in those habitats, including some Threatened and At Risk species.

Based on desktop data, there is at least 1330ha of wetland habitat within the area that would be inundated by the proposed upper reservoir (5TWh option), and approximately 1270ha of wetland habitat that would be inundated by the proposed upper reservoir (3TWh option), including the Fortification Creek wetland complex, Boundary Creek Wetland, and Middle Swamp. Further details on the impacts of the project on wetlands are set out in **Chapter 5: Freshwater**. The loss of these wetlands is considered by Wildlands to be one of the most significant adverse effects of the project.

The other predominant habitat type that would be lost to inundation is tussock grassland, along with smaller areas of rock outcrops; river gorge habitat; riparian gravel fields; and areas of plantation forest and exotic grassland. The construction of the proposed dam would also have impacts on indigenous biodiversity values associated with the area around the Te Awa Makarara/Teviot River.

7.3.1.3 Options to address impacts

Wildlands has provided some preliminary advice to MBIE on the extent to which the known and/or likely impacts on indigenous biodiversity, including terrestrial habitats, could be mitigated or offset.[187] This advice is included as **Appendix E.5 in Volume Two** and describes the nature and significance of the ecological effects that could arise from the project (e.g. loss of wetland habitat); the ways in which the effect might be able to be mitigated or offset, and the risks, benefits and constraints associated with each mitigation or offsetting option.

In general, the options available to mitigate or offset against habitat loss are:

- Select the 3TWh option
- Translocate the habitat to a nearby location
- Undertake restoration or enhancement of nearby habitats.

Selecting the 3TWh option would result in slightly less inundation of habitat areas, but overall would have relatively negligible benefit in terms of reducing impacts on ecological values. That is particularly due to the near-complete loss of wetlands which would happen under either option, and which, as noted above, constitute the ecosystems of greatest value within the Lake Onslow area.

The direct translocation of habitats involves the lifting of vegetation and its immediate subsoil (biotic layer) and transferring it into another site. Indirect translocation can be achieved through the transfer of soils, seeds and slash. s 9(2)(i)

[187] Wildlands Consultants Limited. (2002). *Assessment of options to address the ecological effects of the proposed Lake Onslow pumped hydro scheme*

s 9(2)(i)

[redacted]

Restoration/enhancement of nearby habitats can be a relatively effective offsetting tool, providing the opportunity to benefit several biodiversity types simultaneously. Specific restoration/enhancement actions are dependent on the requirements of the offset site, but can include revegetation, improving hydrology, exclusion of farm stock, and/or controlling introduced predators. Thorough ecological surveys and ongoing monitoring are critical to the design of habitat enhancement and determining the success of the proposed actions.

A combination of translocation and restoration/enhancement would likely be required in respect of the identified habitat loss resulting from the inundation of Lake Onslow.

Detailed advice on the mitigation and offsetting options and the risks and benefits associated with each option is included as **Appendix E.5 in Volume Two**.

7.3.2 Terrestrial plants and vegetation

7.3.2.1 Baseline characteristics

Desktop data reviewed in December 2020 by Wildlands indicates that there are a range of known Threatened and At Risk plants within the inundation area, and that there is the potential for additional species to be present based on the characteristics of the environment.

A total of 267 plant species were identified during the field survey work, of which 220 are indigenous species, and 47 are exotic species. At least 17 Threatened or At Risk species were identified during the field work.

A summary of the total number of Threatened and At Risk plant species that desktop data indicates could be present in the inundation area; and the number of species of plant species that were observed during field survey work is provided in Table 7.3 below.

It is noted that there may be some overlap between the species identified in the columns in this table (i.e. field survey work may have confirmed the presence of pre-recorded plant presence or identified new plant species not recorded in the area to date).

Table 7.3: Summary of Threatened and At Risk plant species in inundation area

Threat category		Records indicate presence in inundation area and surrounds	Plant species observed during field survey work
Data deficient		2	0
Threatened	Nationally Critical	5	1
	Nationally Endangered	3	1
	Nationally Vulnerable	5	0
	Nationally Increasing	0	0
At Risk	Declining	11	10

Threat category		**Records indicate presence in inundation area and surrounds**	**Plant species observed during field survey work**
	Recovering	0	0
	Relict	1	1
	Naturally Uncommon	6	6

Source: Te Rōpū Matatau

The majority of the Threatened and At Risk plant species observed during field survey work were observed below the 740m contour within the areas accessed during field survey work. However, it is likely that some of the observed species are present elsewhere in the un-surveyed parts of the inundation area given the presence of suitable habitat for these species.

7.3.2.2 Impacts

Significant impacts are expected on most notable plant populations within the project area, primarily resulting from the inundation of the land around Lake Onslow. Specifically, inundation could affect at least three, and possibly up to 13 Threatened plant species, and at least 13 At Risk plant species. Other indigenous plant species that are not classified as being Threatened or At Risk would also be inundated, as well as areas of exotic grassland and forestry.

One of the Threatened species identified during field work that will be affected is the kettlehole cudweed *Pseudognaphalium ephemerum* (Threatened-Nationally Critical). This plant is endemic to the eastern part of the South Island of Aotearoa New Zealand from the upper Wairau River in Marlborough to Southland and is generally found in montane to subalpine wetland environments, in places which are flooded in winter and dry out in summer.[188] The Fortification Creek wetland complex is a recognised stronghold for this species, supporting the largest known population in Otago, and one of the largest populations nationally.[189] The Fortification Creek wetland complex may possibly also have the largest population of *Deschampsia cespitosa* in Otago.[190]

The other Threatened plant species identified during field work that will be affected is *Hypericum rubicundulum* (Threatened-Nationally Endangered). s 9(2)(i) [redacted] This species is restricted to lake margins, tarns and other wet depressions and seepages in drought-prone and dry-climate areas of inland parts of the South Island. It is under threat due to its specialised habitat requirements and the increasing pressures on these habitats through much of its range.

Other Threatened species that are potentially present in the inundation area and surrounding landscape (but were not observed during field surveys) include:

- Threatened-Nationally Critical
  - Turf cress *Cardamine mutabilis*
  - Saltgrass *Puccinellia raroflorens*
  - Salt-pan cress *Lepidium kirkii*
  - *Simplicia laxa*

[188] New Zealand Plant Conservation Network. (2022). *Pseudognaphalium ephemerum Fact Sheet (content continuously updated),* https://www.nzpcn.org.nz/flora/species/pseudognaphalium-ephemerum/

[189] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*, page 47

[190] Wildlands Consultants Limited. (2022). *Desktop Assessment of Vegetation and Botanical Values in the Vicinity of the Proposed Lake Onslow Pumped Hydro Storage Project, Otago,* at page 5

- Threatened-Nationally Endangered
  - *Chaerophyllum colensoi var. delicatulum*
  - *Crassula multicaulis*
  - Dryland cress *Pachycladon cheesemanii*
- Threatened-Nationally Vulnerable
  - New Zealand mousetail *Myosurus minimus* subsp. *novae-zelandiae*
  - Climbing broom *Carmichaelia kirkii*
  - Grassy mat sedge *Carex inopinata*
  - *Ranunculus ternatifolius*
  - *Sonchus novae-zelandiae*

There were 17 At Risk plant species recorded during field survey work in those parts of the inundation area that could be accessed for field survey work, and there is the potential for additional At Risk plant species to be present in the wider inundation area.

7.3.2.3 Options to address impacts

Translocation of plants, enhancement/restoration of other habitats, and the establishment of a seed bank are all identified by Wildlands as potentially effective methods of addressing the identified impacts of the project on Threatened or At Risk terrestrial plants. As most of the notable plants at Lake Onslow are currently located below what is proposed to be the minimum operating level, the selection of the 3TWh inundation over the 5TWh is not considered to make much difference to the overall effect of the project on plant life within the area.

Translocation of plants has many risks which result in a highly variable success rate. These include inadequate preparation or selection of recipient sites, bad weather, and physiological stresses on the plants resulting from cuttings or whole of plant translocations. There is a range of methods and techniques which can be deployed to address/reduce some of those risks, as described in **Appendix E.5 of Volume Two**. Alongside translocation, habitat offsetting and the establishment of a seedbank are also considered to be an important part of addressing the effects of the project on Threatened or At Risk plants.

7.3.3 Terrestrial invertebrates

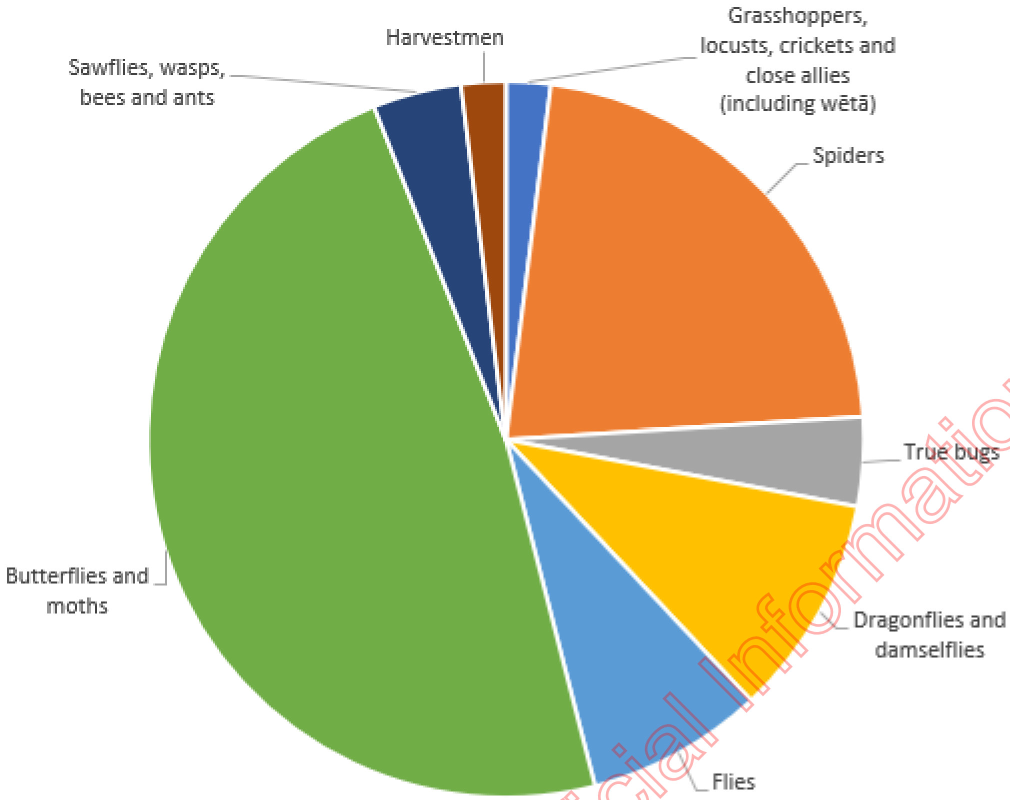
7.3.3.1 Baseline characteristics

The Waipori and Manorburn Ecological Districts support a distinct terrestrial biota that has been described as nationally important. The inundation area contains extensive tussock grasslands that support a range of endemic moth and butterfly species, and wetlands in the basin provide important habitat for a range of invertebrate species.[191]

Invertebrates are difficult to identify to species level, so they tend to be grouped into higher level classifications known as Recognisable Taxonomic Units (RTU) (e.g. genus, family or order). A summary of the number of species observed within the various orders is set out in Figure 7.6 below.

[191] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*, page 47

Figure 7.6: Summary of Invertebrate orders recorded at Lake Onslow, December 2021



Source: Te Rōpū Matatau, based on data provided by Wildlands Consultants Limited. (2022). Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago

Survey work undertaken by Wildlands within the inundation footprint shows that the area supports a range of specialised invertebrate species, including butterflies, moths, spiders, beetles, flies, grasshoppers and dragonflies.[192] A total of 61 terrestrial invertebrate taxa from 34 families were detected during the survey work. However, some species that were expected to be found were not detected, which could be explained by the limited access to properties within the inundation area and the methodological and time limitations experienced by the field team, including the time of year at which the survey work was undertaken (December 2021). [193] Most of the butterflies and moths were found in separate surveys where weather conditions were more favourable and the surveys were focused on butterflies and moths. The other terrestrial invertebrates were surveyed over a single survey during poor weather. Butterfly and moth diversity is therefore better understood than that of the other invertebrate groups.

Desktop data identifies an additional 35 indigenous species and two introduced species that were not observed during field survey work but that have been recorded in, or in close proximity to the inundation footprint. [194]

[192] Department of Conservation. (2022). *NZ Battery Project – Lake Onslow Option: Assessment of Conservation Values at Lake Onslow*, at page 47

[193] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*, page 34

[194] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*, page 48

These invertebrates rely on particular habitats (e.g. tussock grassland, wetlands, rocklands) or specific plant-hosts.

Terrestrial invertebrates are poorly represented in terms of conservation status and many of the species observed do not have a conservation status. Noting that context, no nationally Threatened or At Risk species were observed during the survey, but at least three At Risk species have previously been recorded in the inundation area (during initial investigations) including the moth species, *Heloxycanus patricki, Asaphodes cinnabari* and *Aoraia orientailis*. There is also the potential for known Threatened and At Risk species to be present in the inundation area due to the types of habitats and/or host plants that are present in the area.

Overall, the survey results represent a moderate-low diversity of insects, but one which is relatively typical of upland tussock and wetland habitats. Methodological, seasonal, and time limitations restricted the number and diversity of species detected.[195]

7.3.3.2 Impacts

According to Wildlands, the adverse effects of the project on terrestrial invertebrate species would be substantial, in part because Aotearoa New Zealand invertebrates have a high rate of local and regional endemism. Increasing the size of Lake Onslow to create the proposed upper reservoir would inundate existing habitats for the terrestrial invertebrate species identified above. For the At Risk-Declining moth *Heloxycanus patricki*, the adverse effect of habitat loss through inundation would be high because their only known habitats are found in wetlands in areas of the southern South Island, with the Lake Onslow wetland habitats comprising a moderate to high proportion of the species range. The effects on the moths *Asaphodes cinnabari* and the *Aoraia orientailis* would also be high for similar reasons.

7.3.3.3 Options to address impacts

Research on invertebrate ecology, distribution, taxonomy and/or translocation should be undertaken ahead of determining how adverse effects on invertebrates are addressed, as invertebrates in general are poorly understood. However, based on the information available, Wildlands considers that the following opportunities should be considered if the project proceeds to the next phases, noting that some of these options require further testing, and may need balancing against the other project objectives and operational requirements to ensure that the drivers to advance expediently with the project are recognised:

- Slow inundation at Lake Onslow (which could be over at least a decade) which avoids some direct effects to wetland invertebrates (by providing time for those species to relocate from impacted habitats).[196]
- Salvage and relocation of invertebrates with low dispersal ability, including soil dwelling invertebrates.
- Habitat creation, and enhancement and protection of remaining habitats, for invertebrates which are dispersal-adept. These efforts should be concentrated on areas and habitats that are close to the impact site to allow remaining invertebrate communities to thrive.

[195] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago,* page 49

[196] The reference to a decade is an estimation at this point based on the behaviour and dispersal ability of biota. If this option is considered to be worth investigating further, more research would be required to determine the most appropriate time frame, noting that it could compete with overall project objectives for expediency.

The potential mitigation of effects on terrestrial invertebrates is likely to involve ongoing monitoring, habitat protection and predator control.[197] Further details on these actions, and key priority areas for further research into invertebrates, are described in **Volume Two.**

7.3.4 Herpetofauna

7.3.4.1 Baseline characteristics

Desktop data indicated that there could be up to five species of lizard present within the inundation area.

During field work undertaken in December 2021, access was limited to seven privately owned properties within the inundation area and the Manorburn Conservation Area. Two of the private properties were mostly covered in exotic pine plantation forest and were considered unlikely to contain lizard habitat. Field work was undertaken on the Manorburn Conservation Area and s 9(2)(i) [redacted] Survey locations within these properties were selected based on the likelihood of lizard habitat being present.

Four lizard species were observed during field survey work, s 9(2)(i) [redacted]

[redacted]

Table 7.4: Summary of lizard survey findings (number of individuals detected), Lake Onslow

s 9(2)(i) [redacted]

[197] Department of Conservation. (2022). *NZ Battery Project – Lake Onslow Option: Assessment of Conservation Values at Lake Onslow,* at page 88

[198] A map showing the location of these properties is available at Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*, page 46

* s 9(2)(i) [redacted]

Source: Te Rōpū Matatau, based on data provided by Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago but* s 9(2)(i) [redacted]

s 9(2)(i) [redacted] combined with the survey extent and methods means that the number of individuals will be much higher than observed, and that species not recorded may also be present. [199]

Burgan skink Threatened-Nationally Endangered

The population of Burgan skink in the inundation area is of national significance. It represents a significant 20km westwards range extension for these skinks from the north-eastern side of the Lammermoor Range. s 9(2)(i) [redacted]

Korero gecko At Risk-Declining

This species has fairly wide distribution and is common across much of parts of Otago and Southland. While there is the potential for this species to be present more widely within the inundation area, the abundance of korero gecko appears to be relatively low compared to other locations where over a thousand geckos per hectare can be present. [201]

Southern grass skink At Risk-Declining

Southern grass skink also has a fairly wide distribution from Banks Peninsula southwards, with a preference for damp or well vegetated habitats. Populations of southern grass skink are expected to number in the high millions across Otago and Southland, and this species is likely to be widely scattered throughout damp parts of the inundation area, albeit at low population densities. [202]

Otago green skink At Risk-Declining

This species was not discovered during field work. However, it is rare on farmland, and below the 900m contour. There is a very low possibility of this species being present on properties that were not accessible during the field survey, due to its preference for rocky outcrops and intact

---

[199] Department of Conservation. (2022). *NZ Battery Project – Lake Onslow Option: Assessment of Conservation Values at Lake Onslow,* at page 45-46

[200] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*, page 46

[201] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*, page 46

[202] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*, page 46

tussock and shrublands. These habitat types are of marginal quality within the study area. Determining the presence of this species would necessitate further field work. [203]

McCann's skink Not threatened

McCann's skink was observed as being abundant within the study area, and is common throughout Central Otago. It is the most common indigenous lizard in the South Island and is not threatened. [204]

7.3.4.2 Impacts

Increasing the size of Lake Onslow through inundation to create the proposed upper reservoir would result in the loss of existing habitat for the lizard species identified above, as well as the loss of individual lizards. Inundation could also affect the habitat of as yet unidentified lizard species inhabiting the area.

Construction of the dam, including associated noise and disturbance, could have similar impacts on lizard habitat that may be present within the dam construction footprint.

Of those identified species, the highest impacts would be on the Burgan skink (high to very high) and the Korero gecko (moderate). The impacts on the Southern grass skink require further investigation but may also potentially be moderate. The impacts of the project on the McCann's skink would be low.

7.3.4.3 Options to address impacts

Unlike for most other species and habitats, selection of the 3TWh option would result in significantly less impact on the Burgan skink population compared to the 5TWh option. Burgan skink are only known from elevations above 700mASL, and generally above 750mASL. Depending on their distribution in the area, selection of the 5TWh option could completely avoid any adverse effects on the Burgan skink and their habitat. As with invertebrates, slow inundation of the lake (which could be approximately a decade) would also avoid effects of stress or immediate death and disturbance to lizards and their habitats.[205]

If the 5TWh option is selected, then salvaging of Burgan skink and the Korero gecko populations and transferring them to enhanced and protected habitats would provide important mitigation, offsetting, or compensation. There is uncertainty of success associated with such measures, so research to address critical unknowns is necessary prior to undertaking these actions. A predator proof fence and eradication of introduced mammals within the enhanced habitat area would be essential to mitigate any further losses of these species. As with invertebrates, monitoring will be required to determine the success of habitat creation and salvage survival, and population growth over time.

Salvaging of the Southern grass skink and the McCann's skink is not recommended, so where intervention is required, any impacts on these species would need to be addressed through habitat enhancement.

---

[203] Wildlands Consultants Limited. (2022*). Lizard Species Present (or Potentially Present) in the Vicinity of the proposed Lake Onslow Pumped Hydro Storage Project*, page 4

[204] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*, page 46

[205] The reference to a decade is an estimation at this point based on the behaviour and dispersal ability of biota. If this option is considered to be worth investigating further, more research would be required to determine the most appropriate time frame, noting that it could compete with overall project objectives for expediency.

7.3.5 Avifauna

7.3.5.1 Baseline characteristics

There is limited existing information available on the bird species present at Lake Onslow and the surrounding area.[206]

Wildlands undertook limited field survey work during December 2021 to observe birds within the Lake Onslow basin and surrounding area. The field survey work identified 21 indigenous species of birds and 14 exotic species.

A summary of the NZTCS status of the indigenous birds observed is set out in Table 7.5 below.

Table 7.5: Summary of Threatened and At Risk bird species in inundation area

Threat category		Bird species observed during field survey work	Bird species that may be present in wider area based on desktop data
Data deficient		-	-
Threatened	Nationally Critical	-	-
	Nationally Endangered	Black-fronted tern *Chlidonias albostriatus*	-
	Nationally Vulnerable	Grey duck *Anas superciliosa* Eastern falcon *Falco novaeseelandiae*	Southern crested grebe *Podiceps cristatus australis*
	Nationally Increasing	-	-
At Risk	Declining	Black-billed gull *Chroicocephalus bulleri* Banded dotterel *Charadrius bicinctus* New Zealand pipit *Anthus novaeseelandiae* South Island pied oystercatcher *Haematopus finschi*	-
	Recovering	-	-
	Relict	Black shag *Phalacrocorax carbo novaehollandiae*	-
	Naturally Uncommon	-	-
Not Threatened		14	-

Source: Te Rōpū Matatau, based on data provided by Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*

Because these species have been recorded in the wider area and it contains suitable habitat, there is the potential for the following Threatened or At Risk bird species to be present in the inundation area; however, further work would be required to verify this:

- Australasian bittern *Botaurus poiciloptilus* (Threatened-Nationally Critical)
- Marsh crake *Porzana pusilla* (At Risk-Declining).

[206] Department of Conservation. (2022). *NZ Battery Project – Lake Onslow Option: Assessment of Conservation Values at Lake Onslow*, page 39

Overall, Lake Onslow contains moderate to high bird values as it is one of a few large water bodies in the area with complex shorelines supporting a diverse range of bird species. This makes the lakeshore habitat regionally significant.[207]

Five key bird species were identified in the inundation footprint that are identified as taoka species in Schedule 97 to the Ngāi Tahu Claims Settlement Act 1998:

Table 7.6: Taoka species - birds

Māori name	English name	Conservation status
Kāmana	Crested grebe	Threatened-Nationally Vulnerable
Kārearea	New Zealand falcon	Threatened-Nationally Vulnerable
Pārera	Grey duck	Threatened-Nationally Vulnerable
Pīhoihoi	New Zealand pipit	At Risk-Declining
Kōau	Black shag	At Risk-Relict

Source: Te Rōpū Matatau

The inundation footprint contains substantial area with potentially suitable habitat for the marsh crake (At Risk-Declining) and the Australasian Bittern (Threatened-Nationally Critical), although none were observed during the survey work. The Australasian Bittern is a particularly cryptic species. Potential habitat for those avifauna is contained within parts of the inundation area that could not be accessed due to seasonality constraints and property access limitations.

7.3.5.2 Impacts

Increasing the level of Lake Onslow through inundation will greatly alter lake margins, destroy existing wetlands, and flood river gullies and tussock grasslands. All of these areas provide important habitats for avifauna to breed, forage, moult and nest. For lake margins and wetlands in particular, fluctuating lake levels mean that this habitat is unlikely to be recovered naturally.

Further work is required to determine whether the lake shore of an enlarged Lake Onslow could provide similar habitat opportunities for wading birds, and the extent to which bird species that currently use Lake Onslow and the surrounding area can find suitable breed, forage and nesting habitats in the nearby vicinity. However, based on the preliminary analysis undertaken by Wildlands, the loss of these areas through inundation would likely have very high impacts birds, including on Threatened and At Risk species such as the black-fronted tern *Chlidonias albostriatus,* the grey duck *Anas superciliosa,* the southern crested grebe *Podiceps cristatus australis,* and the eastern falcon *Falco novaeseelandiae.* If the presence of Australasian bittern *Botaurus poiciloptilus* within the Lake Onslow area is confirmed, inundation would also significantly impact this species.

Notwithstanding that, an expanded Lake will continue to provide avifauna habitat in the form of a large extensive waterbody for waterfowl to moult and forage in, as long as there are suitable roosting areas. As set out further below, ensuring these areas develop would be an important part of mitigating the adverse impacts on habitats which would result through inundation.

7.3.5.3 Options to address impacts

Slow infilling of the Lake would avoid some impacts on avifauna, particularly those that use the lake margin or wetlands. A very slow infill rate would also allow avifauna to adjust to the changes in the habitat around the changing water level. Success in this regard would be

[207] Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago,* page 38

enhanced if lake inundation and level changes are undertaken outside of the breeding season to avoid any nesting sites near the water's edge.

Alongside these measures, the following actions could assist in mitigating the impacts of the project on avifauna around Lake Onslow:

- The establishment of floating vegetation platforms on the lake
- The establishment of nesting boxes and other artificial surfaces to provide roosting sites.
- Protection and enhancement of habitat on adjacent land through stock exclusion, predator control and planting of trees and other vegetation for foraging and breeding purposes
- Enhancement of the new lake edge, including levelling out of particular areas to provide flat ground feeding areas for banded dotterel and oystercatcher
- Funds could also be given to enhancing waterbodies that are significant for avifauna in other areas.

7.3.6 Bats

7.3.6.1 Baseline characteristics

The New Zealand long- and short-tailed bats (peka peka) are Aotearoa New Zealand's only native terrestrial mammals. Both species are known to roost in trees, with beech trees being the most favoured. The area around Lake Onslow is generally considered to be of low suitability for bats due to the extensive open landscape and the lack of native forest foraging habitat. However, the plantation forest and wetland areas in the wider area (especially within gorges and canyons) could potentially provide foraging and connective commuting habitat for bats.

Davidson-Watts Ecology undertook a bat survey within the area around Lake Onslow by installing static bat detector loggers between December 2021 and February 2022. Loggers were installed within 7km to the north, west and south of Lake Onslow[208]. No bats/peka peka were identified during field surveys within the area around Lake Onslow. This result was not unexpected given the habitat and landscape types within the area surveyed. While the survey was limited by access to areas, and the climatic conditions, the ecologist considers that the areas with habitats most likely to be used by bats were adequately sampled.

7.3.6.2 Impacts

Given the findings of the bat survey outlined above, it is not likely that the proposed inundation of Lake Onslow will have impacts on bats.

7.4 s 9(2)(i) offtake location

Due to timing constraints, field survey work has not been undertaken at any of the proposed offtake locations. Preliminary desktop data indicates that there is a sizeable area of makahikātoa (Threatened-Nationally Vulnerable) shrubland and rock outcrop vegetation at the s 9(2)(i) offtake location. This habitat is likely to provide habitat for indigenous lizards and invertebrates, and a large area of this habitat would be removed in order to construct the intake structure. [209]

No data is available to date on the potential presence of birds and bats at this location.

---

[208] Refer to Figure 1 of Davidson-Watts Ecology (Pacific) Limited. (2022). *Lake Onslow Area Bay Survey*.

[209] Wildlands Consultants Limited. (2022). *Desktop Assessment of Vegetation and Botanical Values in the Vicinity of the Proposed Lake Onslow Pumped Hydro Storage Project, Otago*, page 11

There are no protected areas identified in the Central Otago District Plan or Regional Plan: Water in the immediate vicinity of the s 9(2)(i) offtake location.

7.5 s 9(2)(i) offtake location

As noted above, field survey work has not been undertaken at the s 9(2)(i) offtake location. Preliminary desktop data indicates that the rock outcrops on hillslopes on the north-eastern side of the proposed lower reservoir could provide habitat for Threatened and At Risk lizard and plant species.[210] Establishment of a reservoir at this location would likely necessitate cutting into these slopes and therefore impacting on this potential habitat.

No data is available to date on the potential presence of terrestrial invertebrates, birds and bats at this location.

There are no protected areas identified in the Central Otago District Plan or Regional Plan: Water in the immediate vicinity of the s 9(2)(i) offtake location.

7.6 s 9(2)(i) offtake location

Field survey work has not been undertaken at the s 9(2)(i) offtake location. Preliminary desktop data indicates that the proposed reservoir would mostly intersect with bracken fern land; pasture; and indigenous grey shrubland. Rock outcrops are present in several locations within the proposed reservoir footprint.

The rock outcrops could provide habitat for Threatened and At Risk plant and lizard species, and the grey shrubland could provide habitat for At Risk plant species.

No data is available to date on the potential presence of terrestrial invertebrates, birds and bats at this location.

There are no protected areas identified in the Central Otago District Plan or Regional Plan: Water in the immediate vicinity of the s 9(2)(i) offtake location. s 9(2)(i) are located on the opposite side of the Mata-Au/Clutha River approximately 1km from the proposed reservoir and the s 9(2)(i) are located approximately 2km to the north of the proposed reservoir, s 9(2)(i)

There is the potential for road upgrades/realignments to affect the Rigney Pond Margins, and further work is required to understand whether the construction of the proposed reservoir at this location could have hydrological impacts on the Island Block Pond Marshes (due to any in-river works required to construct the intake structure).

7.7 Summary

While there are considerable areas of land within the project area which have not yet been assessed, it is considered that the information available to date provides sufficient certainty as to the nature and significance of effects on indigenous biodiversity that will arise as a result of the project.

In short, it is clear that the inundation of Lake Onslow, and the consequential deepening of the Lake together with the proposed variability of lake levels would have significant, wide-ranging adverse effects on terrestrial ecological features and values within the project site, including inundation of extensive natural wetlands, exceptional examples of naturally rare habitats, important diversity and habitats for invertebrates (particularly Lepidoptera), important

[210] Wildlands Consultants Limited. (2022). *Desktop Assessment of Vegetation and Botanical Values in the Vicinity of the Proposed Lake Onslow Pumped Hydro Storage Project, Otago*, page 11

populations of Nationally Threatened plant and lizard species, and regionally significant sites for notable bird species (see Table 7.8).

Table 7.7: Threatened and At Risk species affected by the project (as identified to date)[211]

Threat status	Plants	Birds	Lizards
Threatened-Nationally Critical	Kettlehole cudweed *Pseudognaphalium ephemerum*	-	-
Threatened-Nationally Endangered	*Hypericum rubicundulum*	Black fronted tern *Chlidonias albostriatus*	Burgan skink *Oligosoma burganae*
Threatened-Nationally Vulnerable	-	Grey duck *Anas superciliosa* Eastern falcon *Falco novaeseelandiae*	-
Threatened-Nationally Increasing	-	-	-
At Risk-Declining	Buchanan's sedge *Carex buchananii* Red leaved swamp sedge *Carex tenuiculmis* Desert broom *Carmichaelia petriei* Pygmy clubrush *Isolepis basilaris* *Lobelia ionantha* *Mentha cunninghamii* *Olearia lineata* *Parahebe canescens* *Pterostylis tanypoda* *Raoulia australis*	Black-billed gull *Chroicocephalus bulleri* Banded dotterel *Charadrius bicinctus* New Zealand pipit *Anthus novaeseelandiae* South Island pied oystercatcher *Haematopus finschi*	Korero gecko *Woodworthia* 'Otago/Southland large' Southern grass skink *Oligosoma aff. polychroma* Clade 5 Otago green skink *Oligosoma aff. chloronoton* 'Eastern Otago'
At Risk-Recovering	-	-	-
At Risk-Relict	*Leptinella maniototo*	Black shag *Phalacrocorax carbo novaehollandiae*	-
At Risk-Naturally Uncommon	New Zealand anemone *Anemone tenuicaulis* *Epilobium angustum* Dwarf rush *Juncus pusillus* *Montia angustifolia* *Menegazzia castanea* Lichen *Teloschistes fasciculatus*	-	-

Source: Source: Te Rōpū Matatau, based on data provided by Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago*

The unavoidable loss of extensive, diverse and rare wetlands will be one of the most significant adverse effects of the project, and while there are options for transfer of wetland biota, these are

[211] This table does not include data deficient species, but it is important to note that there may be other species that are Threatened or At Risk but this cannot be confirmed due to a deficiency in data. The table does not include terrestrial invertebrates because tterrestrial invertebrates are poorly represented in terms of conservation status and many of the species observed do not have a conservation status. Noting that context, no nationally Threatened or At Risk species were observed during the survey, but at least three At Risk species have previously been recorded in the inundation area (during initial investigations).

associated with a high degree of risk. Addressing adverse effects on wetlands is therefore considered to be best focussed on protecting and enhancing other similar wetlands in the local landscape, but also, critically, accepting a net loss of wetland extent.

Although further research is required to clarify the viability of these techniques, measures are available for mitigating some of the effects on plant and animal species although again, it is likely that significant offsetting and compensation will also likely be required. Wildlands considers that offsetting is preferred to compensation because its outcomes are verifiable.

Internationally recognised guidelines, and principles reflected in the draft National Policy Statement for Indigenous Biodiversity (NPS-IB) and NPS-F recognise that a tiered approach to managing effects (avoiding, remedying, mitigating, offsetting then compensation) will provide the best method of addressing the impacts of the project because it is adaptive and sufficiently complex to address the variety of ways in which those impacts would be experienced.

Based on research to date, such work will be a task of considerable magnitude, in terms of time, cost and resources. In addition, substantial information gaps exist across many of the mitigation and offsetting options, with none of them considered to be risk free. Significant baseline research is also recommended to be carried out before the mitigation options are selected. Offsetting will require extensive baseline data collection, management and monitoring, some of which will need to occur over long periods of time.

s 9(2)(g)(i) [redacted]

7.8 Recommended future actions

If the project progresses, it is recommended that the following work is undertaken to improve understanding of the existing indigenous biodiversity within the project area, the ways in which the project may impact that, and options for addressing those impacts:

- Further survey work to identify invertebrate and insect species and their habitats, terrestrial plants, vegetation and habitats, within the remaining extent of the inundation area.
- Further survey work to identify and understand the distribution of the Nationally Endangered Burgan skink within the full extent of the inundation area.
- Confirm the existence of habitats within the Lake Onslow inundation area for the marsh crake (At Risk-Declining) and the Australasian Bittern (Threatened-Nationally Critical)
- Survey work to identify existence and extent of indigenous biodiversity within the Fortification Creek wetland complex.
- Further survey work and analysis of the indigenous biodiversity values at:
  - the s 9(2)(i) [redacted] offtake location and the s 9(2)(i) [redacted] offtake location
  - s 9(2)(i) [redacted] offtake location, and the potential for the project to affect the s 9(2)(i) [redacted]

8 Natural character, features and landscapes

This chapter describes the existing landscape character and values of the project area and the potential landscape and visual impacts from the project. It is informed by technical assessments undertaken by landscape experts, Blakely Wallace Associates.

8.1 Baseline natural character, features and landscapes

The Landscape and Visual Assessment (2021) has identified three distinct landscape units within the project area (refer to Figure 8.1) namely:

1. Mata-Au/Clutha and Teviot Valley
2. Teviot/Beaumont Downs
3. East Otago Uplands.

s 9(2)(i)

[redacted]

8.1.1 Mata-Au/Clutha and Teviot Valley

The Mata-Au/Clutha and Teviot Valley Landscape Unit covers the area of Lake Roxburgh Gorge above the Roxburgh Dam including the topographically defined Teviot Valley downstream to approximately Beaumont.

8.1.1.1 Landscape character

As set out in the Landscape and Visual Assessment, upstream of the dam wall Lake Roxburgh is tightly contained in a flooded valley within an arid, deeply incised, rocky schist gorge. The arid and rocky Knobby Range rises to the northeast of the gorge, with Gordon Peak (1004m) and Pinelheugh (1124m) prominent on the skyline to the east.

Below the dam, the valley opens out to the mainly alluvial flats of the Teviot Valley, with the Mata-Au/Clutha River as the central focus. The much higher Old Man Range/Kopuwai and Mt Benger form the steep enclosing mountain slopes on the western side with the lower Teviot hills and Downlands enclosing the east side of the Teviot Valley.

The lower hillslopes on both sides of the valley are mainly used for pastoral farming, with the Te Awa Makarara/Teviot River and other side tributaries cut down into the hillslope with extensive rock outcrops and exposure. The Teviot Valley is dominated by intensive horticulture, orchards and farmland together with the dwellings, structures, irrigation ponds and infrastructure associated with those activities.

8.1.1.2 Visual/scenic values

The Mata-Au/Clutha and Teviot Valley Landscape Unit is assessed to have high visual and scenic values due to the combination of exposed and steep rocky slopes, flat valley floor and the visually dominant Mata-Au/Clutha River. Views of the river and the scale of the gorge are integral to its visual and scenic values but the wider area also has high visual values related to both its natural and pastoral character.

Blakely Wallace Associates assess this Landscape Unit to have a low to moderate vulnerability to change. The working landscape of the valley floor is considered to be capable of absorbing landscape change, with the enclosing hill slopes especially higher up visually more sensitive to change.

Figure 8.2: Photograph of the Teviot Valley looking southwest

Source: Blakely Wallace Associates, 2021

8.1.2 Teviot/Beaumont Downs

The Teviot/Beaumont Downs Landscape Unit is a transitional area between the Mata-Au/Clutha and Teviot Valley and the more natural adjoining East Otago Uplands.

8.1.2.1 Landscape character

This area has a distinctive rolling landform which is predominantly used for pastoral farming. The terrain within this area is typically dry, rocky native shrublands with much of the natural tussock cover having been removed apart from in the steeper gullies, and on the higher eastern ridge leading up to the Onslow Basin and the Pinelheugh ridge. Forestry blocks are dominant new features within the unit which have resulted in significant landscape change.

8.1.2.2 Visual/scenic values

This landscape unit is identified as having average visual and scenic values, being a pleasant working farm landscape in an elevated location with outstanding view to the adjoining ranges. The repetitive rolling landform and dissected gullies are memorable features.

The Teviot/Beaumont Downs Landscape Unit is open and exposed and is therefore considered by Blakely Wallace Associates to be sensitive to change, while acknowledging that the degree of modification that has already occurred from agriculture, forestry, and hydroelectricity development provides some capacity to absorb further change.

Figure 8.3: Photograph of Te Awa Makarara/Teviot River at it lower reaches, incised into the Downlands escarpment

Source: Blakely Wallace Associates, 2021

8.1.3 East Otago Uplands

The East Otago Uplands Landscape Unit encompasses the whole of the Upland Plateau with essentially similar characteristics. These upland areas include the Upper Manorburn/Greenland, South Rough Ridge, Lammerlaws/Lammermoors and extending towards the Rock and Pillar Range.

8.1.3.1 Landscape character

Common to the whole of the extensive eastern Otago Uplands landform is the undulating, smooth, rolling, often flat crested, dissected hills from about 500m to over 1000m. A repetitive pattern of ridges and spurs extend as far as the eye can see, sometimes backdropped with the distant higher ranges of Otago. Tussock both tall and short (typically tawny brown colour and fine textured) is a dominant and unifying element across the whole area in varying condition. There are wide basins such as Lake Onslow with broad ridges separating the catchments as well as smaller basins like Teviot Swamp.

The basement rock of the Upland Plateau is Otago schist formed by folding and uplift and subsequent erosion, creating the relatively flat summits typical of the Otago peneplain. Stream beds between ridges are fluvial deposits. Extensive and important wetlands are a feature of the Upland such as Teviot Swamp, Red Swamp and Middle Swamp. While there are obvious signs of cultural modification, the entire area has a high degree of naturalness and natural character and, significantly, appears as a natural landscape, particularly as the main types of cultural modification are the presence of large man-made reservoirs (Lake Onslow, Greenland and

Upper Manorburn, Poolburn, and Logan Burn Reservoirs) which are located within natural basins and which have softened over time such that they are now accepted parts of the landscape.

8.1.3.2 Visual/scenic values

As a result of the expansive nature of the repetitive landform of smooth spurs and ridges, dissected drainage patterns and dominant homogenous tussock grassland, this Landscape Unit has very high visual and scenic values. The expansive openness, back-country character, sense of isolation and wildness including presence of wildlife, contribute to the landscape values of this area.

The Onslow Basin is one of the largest basins of the upland area. The lake forms a roughly horseshoe shape with fingers extending up drainage lines following contours with some small islands above the waterline. The Lake also has high visual values, in part due to being part of the greater upland landscape but also due to the characteristics and features of the lake and basin in isolation of its broader context.

Blakely Wallace Associates assess this Landscape Unit to be highly vulnerable to change with the naturalness and natural character of the landform and the dominant vegetation characteristics (tussock and wetlands) its most vulnerable aspects. Blakley Wallace Associates considers all of the East Otago Uplands is at least of regional significance and more likely of national significance.

Figure 8.4: Photograph of the East Otago Uplands area, looking west over Lake Onslow

Source: Blakely Wallace Associates, 2021

8.1.4 Summary of landscape unit values

Blakely Wallace Associates have considered each Landscape Unit against a set of criteria comprising:

- Naturalness
- Legibility
- Tangata whenua values
- Aesthetic factors:
  - Distinctiveness – the quality that makes a particular landscape visually striking and impressive
  - Coherence – intactness, unity, continuity
  - Diversity
- Transient values
- People and communities shared and recognised values
- Memorability.

For each criterion, the landscape unit is assessed as having low, average, medium, or high value.

A summary of that assessment is set out in **Table 15.1**. As can be seen the East Otago Uplands Landscape Unit contains the highest values in all categories. Further detail is provided in Section 6 of the Landscape and Visual Assessment (2021) in Volume Two.

Table 8.1: Summary of the landscape values in each landscape unit

Criteria	Mata-Au/Clutha and Teviot Valley	Teviot/Beaumont Downs	East Otago Uplands
Naturalness	Low	Medium	High
Legibility	Medium	Medium	High
Tangata whenua	Medium	Medium	High
Aesthetic factors	Medium	Medium	High
Transient values	High	Medium	High
Peoples and communities shared and recognised values	High	Medium	High
Memorability	Medium	Medium	High

Source: Te Rōpū Matatau, adapted from Blakely Wallace Associates. (2022). *NZ Battery Project – Landscape and Visual Assessment*

8.1.5 Outstanding Natural Features/Landscapes and Significant Amenity Landscapes

In addition to the work undertaken by Blakely Wallace Associates, a review of the Central Otago District Plan identifies Outstanding Natural Features (ONF), Outstanding Natural Landscapes (ONL), the Upper Manorburn/Lake Onslow Landscape Management Area (LMA) and Significant Amenity Landscapes (SAL) in the region.

As shown on Figure 8.5 below, the project area is located immediately adjacent to the East Otago Uplands ONL. The inundation area is located entirely within the Upper Manorburn/Lake Onslow LMA, while the indicative locations for the waterway tunnels and associated portals partly intersect with SAL. The District Plan provisions provide protection for land in the LMA largely commensurate with the status of an ONL (i.e. there is a greater level of restriction on activities that can be carried out within these identified areas).

s 9(2)(i)

8.2 Impact of project on baseline values

Preliminary assessment indicates that the loss of the extensive wetlands and other features within the Lake Onslow basin as a result of raising the lake[212] will result in the most significant landscape and visual impacts of the project. The Onslow Basin is acknowledged to be the most modified part of the Upland area and the effects of raising the Lake would be largely contained within the Onslow Basin due to the natural landform conformities. However, the raised lake would mean the reservoir is visible from a wider catchment, especially from many of the high points of the upper plateau.

In addition, the operating range for the upper reservoir is considered likely to significantly impact the landscape and amenity values of this environment with the effects from a large operating range ongoing, while the initial filling of the reservoir would be a temporary effect, and therefore of less concern.

The proposed dam will be a very large man-made structure introduced to the Uplands area and while there is a presence of existing man-made infrastructure in the catchment, the proposed scale of the dam is not comparable to that of the existing environment. The infrastructure and the operation of the dam would reduce the naturalness of the landscape and the back-country character and the area's sense of isolation would be reduced.

Other features likely to be lost include significant areas of tussocks and indigenous vegetation, tributary watercourses, wetlands, and oxbow lakes.

Overall, the Landscape and Visual Assessment finds the potential impacts on the Onslow Basin within the East Otago Uplands landscape character unit to have a 'Very High' adverse impact on landscape character.[213]

In terms of the three potential offtake options, the Landscape and Visual Assessment indicates that the s 9(2)(i) [redacted]

s 9(2)(i) [redacted] The high and unnatural bund and reservoir shape along with the built components such as fish-screens would be incongruous with this location and, compared to the other options, more difficult to absorb into the existing environment.[214]

In addition, while the impacts of construction have not been assessed in detail, the introduction of construction personal, vehicles and equipment will also alter the predominant land use and change the naturalness of the area. For construction of the underground infrastructure, a very large volume of earthworks is likely to be required and it is expected there would be obvious evidence of stockpiling excavated material which has the potential to significantly impact the landscape character of the area. It is accepted that temporary access tracks required for the construction of the project are likely to be able to be rehabilitated and reinstated, and therefore unlikely to have long-term impacts on the landscape. Some road access and structures present

[212] Blakely Wallace Associates. (2021). *NZ Battery Project – Landscape and Visual Assessment,* at page 36
[213] Blakely Wallace Associates. (2022). *Addendum Report – Landscape*, page 2
[214] Blakely Wallace Associates. (2022). *Addendum Report – Landscape*, page 4

at the surface (i.e. surge-shafts and access portals) will, however, become permanent features in the landscape.

8.3 Options to address impacts

The following opportunities to avoid, remedy or mitigate potential landscape and visual impacts are outlined in the Addendum Report (2022):

- In terms of landscape and visual amenity impacts, the s 9(2)(i) [redacted] offtake options are preferred as they have either existing hydro-dam infrastructure or have existing landforms which would provide some natural screening of the proposed infrastructure from prominent viewpoints.
- A simple functional dam structure that is responsive to the topography and landform would assist with integration to the site and reduce adverse impacts on the landscape.
- Excavated soil deposition sites should be integrated into the natural landform where possible.
- Remediation and revegetation of disturbed areas would be integral to mitigation of landscape and visual impacts.
- Reducing the operating range of the upper reservoir would assist in reducing the potential adverse effects on the landscape although it is acknowledged that the operating range of the project is fundamental to its purpose.

8.4 Information gaps and risks to decision-making

The landscape and visual assessments to date are high-level but provide sufficient detail to identify the scale of effect likely as a result of the project. The three landscape units contain a range of landscape and amenity values, some of which are assessed to be very high, and the project is assessed to have a very high adverse impact on these.

Additional detailed information should be obtained on the likely impacts of the project on the natural character, landscape and visual values of the project area and its surrounds.

8.5 Recommended future action

If the decision is made for the project to proceed, a detailed assessment of natural character, landscape and visual impacts should be undertaken, following the New Zealand Institute of Landscape Architects guidelines.

9 Social

This chapter identifies the existing communities within which the project area is located, and the potential positive and negative social impacts from the project on those communities. It also outlines potential opportunities and initiatives which could be employed to avoid, remedy, mitigate, offset or enhance those potential impacts.

This chapter has been informed by the preliminary social impact assessments (SIA) undertaken by Nick Taylor and Associates, available as **Appendix G.1 and G.2 in Volume Two**.

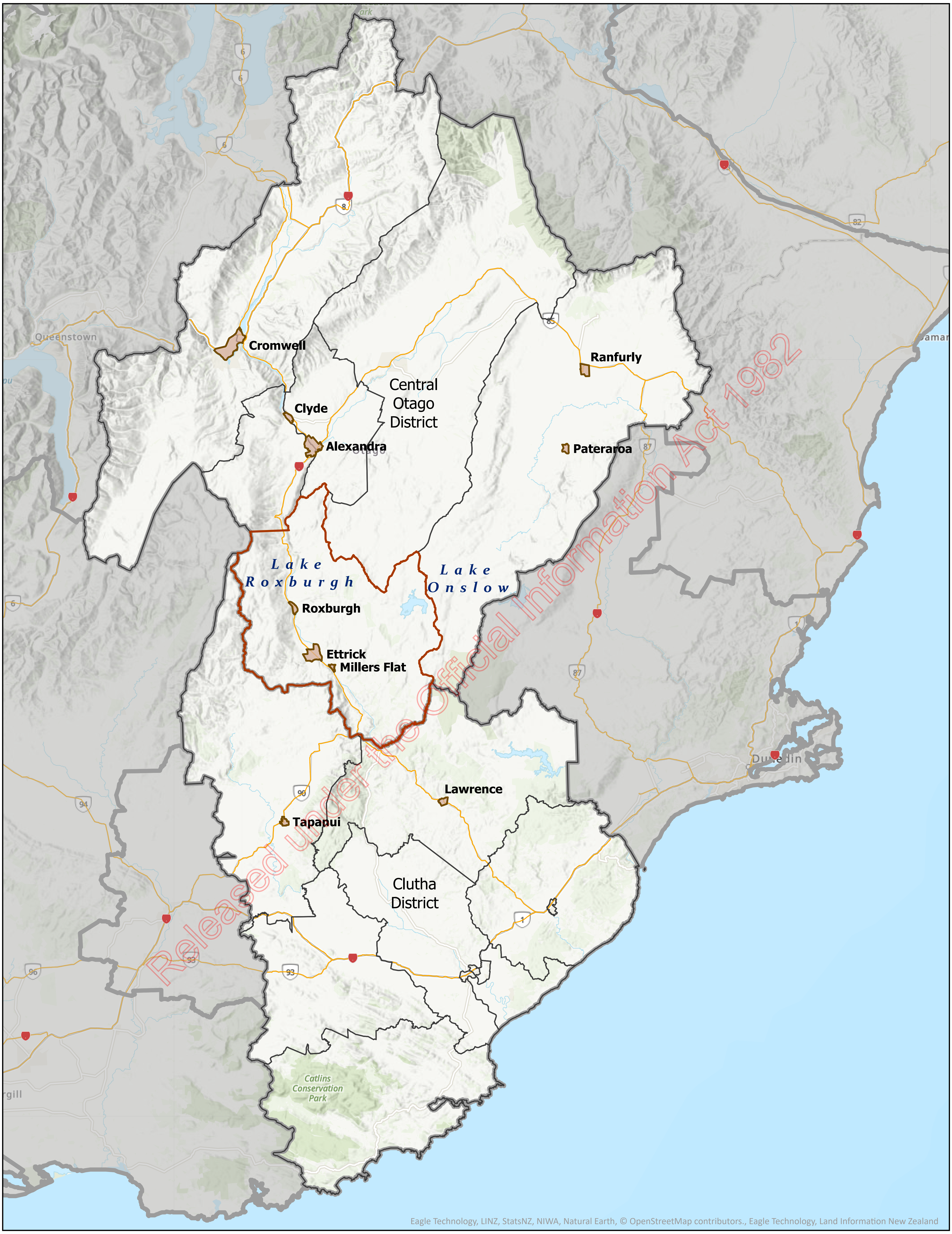
9.1 Assessment methodology

The first phase of social impact assessment identified the spatial scope of the potentially affected communities, comprising both the Central Otago and Clutha Districts. That assessment area is illustrated in Figure 9.1 below. The scoping analysis was then followed by an interim assessment of the social impacts on those communities, drawing on information gathered through desktop studies of existing strategies and policy documents, community descriptions, site visits, and community engagement activities in the Teviot Valley area.[215]

Through this process, a number of parties were specifically identified as indicative 'affected stakeholders'. The full list of those stakeholders is set out in Table 2 of the Interim Assessment and includes mana whenua, central and local government organizations, sector groups and non-government organizations, community groups, and directly affected people (such as landowners).[216]

[215] Nick Taylor and Associates. (2022). *Aotearoa/NZ Battery Project – Interim assessment of social impacts for Lake Onslow pumped hydro scheme option*, page 8

[216] Nick Taylor and Associates. (2022). *Aotearoa/NZ Battery Project – Interim assessment of social impacts for Lake Onslow pumped hydro scheme option,* Page 25



Paper Size ISO A3

0 5 10 15 20

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: NZGD 2000
Grid: NZGD 2000 New Zealand Transverse Mercator

N

TE RŌPŪ MATATAU
CONNECTED IN THINKING AND ACTION

Legend
- Urban Settlements
- Teviot Valley
- Statistical Area 2 Boundaries
- Territorial Authority

Ministry of Business, Innovation & Employment
NZ Battery Project: Lake Onslow Pumped Hydro Storage Option

9.1 Study area for Social Impact Assessment

U:\2021\BM210219_KGi_Project_Onslow\GIS\BM210219_EIS_template.aprx
Print date: 18 Aug 2022 - 09:08

Data source: Statistical units sourced from SNZ data service
Reviewed: BLi
Created by: scooter

9.2 Baseline environmental characteristics

The Clutha and Central Otago Districts include the following settlements:

- Cromwell and Lake Dunstan
- Alexandra, Clyde and the Manuherikia Valley
- Ranfurly, Paerau, Patearoa and the Maniototo
- Teviot Valley and Roxburgh, Ettrick and Millers Flat
- Lawrence, Tuapeka and Tapanui
- Lake Onslow (comprising anglers huts).

9.2.1 Population characteristics

Based on census data from Statistics NZ approximately 24,790 people live in the Central Otago District, and 18,490 live in the Clutha District in 2021. The Central Otago population is largely concentrated within the main urban areas of Cromwell and Alexandra (accounting for more than half of the District's population).

Approximately, 1880 people live in the Teviot Valley, with Roxburgh being the largest settlement (620 people), followed by Ettrick (180 people) and Millers Flat (90 people).[217]

The population of Central Otago is projected to reach 31,560 in 2048, growing by 27% from 2021, with most of this growth expected to occur in Cromwell and Alexandra.

The population of the two districts has an older age profile than the national profile, which has implications for the supply of labour and the demand for social services.

In Central Otago, 92% of the population identify as European, and 89% in the Clutha District, which is higher than the national statistic of 70%. The proportion of people who identify as Māori, Pacific Island and Asian groups are lower across the project area than the national average, with Māori representing 8% of the Central Otago District and 12% of the Clutha District population compared to 17% nationally.

The economy of the Central Otago and Clutha Districts is primarily based on agriculture, horticulture, forestry and tourism, supported by the service sectors. Construction activity and hydro-electricity operations are also contributors to the economy. These sectors tend to be more sensitive to disruptions from international markets, worker shortages, weather and logistical vulnerabilities and in that regard the global coronavirus pandemic in particular has had a significant impact on the wider Otago region.

9.2.2 Key community values

Through the research and community engagement process, the Interim Assessment identified the following key values of the potentially affected communities:

- Pastoral farming is active throughout the area and provides a high degree of social stability through farm succession, participation in community life and stewardship values.
- Horticulture is also an important form of primary production for the Central Otago District, originally most evident on the river flats of the Teviot Valley and now in the extension of wineries and summer fruit through the upper catchment of the Mata-Au/Clutha River.
- Food processing varies, with beverage production including wineries and distilleries becoming increasingly common. Fruit packing is common but processing is now limited. Meat processing is located in the Clutha District and milk processing in nearby Southland.

[217] Nick Taylor and Associates. (2022). *Assessment of Social Impacts (Scoping),* page 14

- Irrigation is vital for horticulture and any intensification of farming including dairy production, and also for summer and winter feed production that increases the productivity of large-scale pastoral farming systems. Irrigation widely utilizes old mining permits and races, and communities are actively involved in processes to set water quantity and quality limits.
- There are many diverse landscapes, cultural and heritage sites valued by mana whenua, local communities, recreationists, and visitors. These form the basis for community identity and a strong localized sense of place with gold mining and farming histories highly valued (with strong connections to this heritage fostered by the presence of multi-generational residents).
- The sense of place, high amenity values, opportunities for outdoor recreation, and peacefulness attract retirees and remote workers.
- There are strong values of small, close-knit communities with emerging concerns around the direction of development, population growth, visitor numbers, social diversity and community cohesion.
- Social services in health, education and local government are highly valued, particularly amid concerns about maintaining sufficient population to keep services viable.
- Strong values of resilience and social capital emphasise self-sufficient rural communities with a strong but diminishing volunteer base, such as support for the volunteer fire brigades, local primary schools, community libraries, halls, pools and services for the elderly.
- Economic development is highly valued, especially development that creates employment opportunities that attract young people and people with families.

9.2.3 Social themes/challenges

The Interim Assessment identified the following key themes/challenges being encountered by the potentially affected communities.

9.2.3.1 Community adaptation

The study area has a history of adaptation and reinvention with successive periods of economic development around resource cycles of gold mining, pastoral farming, and production of wool, meat, summer fruits, grapes and wine. In more recent times, outdoor recreation, tourism and hydroelectricity have strongly influenced the community characteristics and the local economy. River systems still connect communities, fostering interdependence up and down stream. Social capital is strong with a heavy reliance on community volunteers, providing strong resilience. Newcomer population groups add to these characteristics and drive further adaptation.

9.2.3.2 Population growth and decline

Population growth and increasing economic production can support and also put pressure on existing lifestyle values, services and infrastructure. The presence of seasonal workers and newcomers can affect community participation and the social and cultural make-up of the communities. Efforts to foster community connection are important when there are significant population growth and rising house prices projects (as experienced in Cromwell and Alexandra), making the smaller rural communities more attractive as places to live and commute to work.

9.2.3.3 Housing

The supply and affordability of housing is a particular constraint on development, with communities that are experiencing the highest population growth seeing the greatest pressure on housing supply. Short-term and seasonal housing is an ongoing issue for incoming and transient workers.

9.2.3.4 Economic challenges

As noted above, the study area is impacted by national and global economic cycles. In the years before the pandemic, the area experienced significant growth in employment and population numbers, along with increases in international workers and visiting tourists. During the pandemic, primary production and the domestic visitor market were an important part of the local economy, with the exploration of new cycle trails proving to be particularly popular. Post pandemic growth challenges include staffing shortages, particularly in horticulture, tourism, and hospitality. A shortage of skilled labour and small local markets present business challenges, along with transport costs and the time/distance from suppliers and services, and training.

9.2.3.5 Construction employment

Construction employment is a well-recognized problem in the Otago region, with research showing there is a significant shortfall of construction workers for already approved and planned projects. Central and local government groups are tasked with attracting, retaining, and developing (recruit, train and upskill) workers to support the pipeline of work, including providing appropriate and affordable housing.

9.2.3.6 Infrastructure

There are significant and ongoing issues for reliable water supplies due to climate change and new regulations for water quality, extraction and minimum flows. The costs of water upgrades in smaller settlements are significant with a low ratepayer base. Some roads and internet services also require upgrades.

9.2.3.7 Community facilities

There is a strong focus on maintaining and upgrading community facilities, which provide an important service and attract new residents. There is a significant economic development associated with community-driven investments such as the emerging cycle trail network (which acts as an anchor attracting external funding and promoting other development proposals).

9.2.3.8 Protection of the natural and cultural environment

As noted above, the natural, cultural and historic heritage environment is of significant value for residents, visitors and iwi. There are environmental concerns for developments including more intensive farming and recreational activities that could affect outstanding landscapes, green spaces, the sense of place, heritage values, air quality, and waste management.

9.3 Impacts of project on the baseline characteristics

The Interim Assessment used the community engagement and documented experiences from other large hydroelectricity projects (both internationally and within Aotearoa New Zealand) to identify potential social impacts of the project on the study area communities and their values.[218]

9.3.1 Impacts on farmers and farm operations

Land acquisition for the project would happen over several years and would include the loss of up to 6,000 hectares of farmland to the Upper Reservoir. Additional farmland would be required for new infrastructure including the dam, lower reservoirs, road improvements and construction areas. Through community consultation, landowners and farmers have raised concerns that the loss of land could affect the integrity of farm operations, as a range of low, medium and high-country land is optimal to a high-performing farm in this region, given the different pasture types

[218] Nick Taylor & Associates identify the potential for social impacts across all stages of the project lifecycle from the approvals/decision making stage through to operation.

provide different seasonal grazing. The areas required for the inundation of Lake Onslow, in particular, will result in the loss of valuable, summer-safe, grazing country and some feed crops.

Changes to farm operations and ownership could impact the long-standing pastural farming practices and traditions of this area. Furthermore, if farming families are disrupted, this could have impacts for the social capital of these small communities due to the role that these families play in community leadership, school attendance and upkeep, and voluntary activities.

Concerns were also raised about how the project may affect the ability for farmers to continue to take water from nearby waterbodies or groundwater bores for irrigation purposes.

An increase in traffic numbers and heavy vehicle movements on the local road network could cause delays and increase the risks to farmers, rural residents, and other drivers. The traffic on access roads could also affect farm operations, as road areas are currently used for grazing and stock movements. Furthermore, physical and visual effects from construction works could affect livestock, cultivation, and grazing patterns, as well as reducing amenity for farmers and workers working in relatively isolated and peaceful settings.

More broadly, the Interim Assessment records that, to date, the project has generated significant uncertainty and stress for farm owners, farm workers and their families within the project area. Farm planning for the short and longer term (including succession and retirement planning) has been disrupted, and this has impacted the resilience of affected families. If uncertainty regarding the project persists and the project enters a detailed phase of post-feasibility planning, these impacts can reasonably be expected to continue. The Interim Assessment considers that during this phase, consistent communication and engagement with the community will be required.

9.3.2 Impacts on recreation and tourism

Community consultation undertaken to inform the Interim Assessment reiterated the recreational values addressed in **Chapter 10: Recreation**, confirming that the local people are active users of Lake Onslow and that it is highly valued as a local recreational resource. As set out in **Chapter 10: Recreation**, the project is expected to have a significant impact on the Lake's value as a recreational fishing location for local residents as well as visitors.

Similarly, there is concern about potential adverse impacts on the Roxburgh Gorge and Clutha Gold Cycle Trail along the Mata-Au/Clutha River which could include rerouting, creating a less desirable route and disruption during construction which may deter visitors from the area. Another concern was the added demand on worker accommodation which could reduce that available for tourism, which is already strained during summer months and can result in the displacement of cyclists to touring options in other regions.

Community consultation also raised the prospect of positive impacts for future recreational and tourism opportunities brought about by the increased profile of the area from the project. This could include opportunities for local farm-based tours and accommodation, four-wheel drive tours, cycle tours, and an expanded commercial air service out of Alexandra airport.

9.3.3 Impacts on amenity

The physical works within the project area, both during construction and operation, could generate adverse effects that could in turn reduce or erode amenity values within the area. Those effects include visual changes in the landscape, and increased noise, dust, rubbish, signage, and traffic.

Community consultation raised traffic as a particular concern, and highlighted issues around potential delays in travel time, increased heavy vehicle traffic, increased congestion and increased parking demand for local townships. It was identified that some existing roads, bridges and intersections would need to be upgraded to improve safety for all users. As noted in **Chapter 11: Heritage**, there are several bridges in close proximity to the project area which are listed heritage items in the Central Otago District Plan.[219]

9.3.4 Employment, population and housing

As with any large-scale infrastructure project, construction of the project will bring changes in the employment, population and housing landscape of the study area. A large construction workforce will be required, for example, which is estimated to be up to 2500 people over seven years, with a peak of 1000 workers at any one time. The trends in employment for inland Otago show that there is currently an insufficient workforce to meet the regional needs for committed projects. Options for meeting the extra demand for workers from the project would need to be carefully planned, and include targeted sourcing of workers from elsewhere.

During the Interim Assessment, the community expressed concerns around the management of these workforce changes and the opportunity for this to enhance, rather than detract from, social outcomes. In particular:

- An influx in construction workers and others associated with the project could cause social disruption and additional demands on the housing market, social services, community services and social cohesion. The community also recognised that more people in the districts could also support the viability of services such as healthcare facilities and schools.
- New short-term accommodation and a form of construction camp would likely be required to accommodate the incoming construction workers. Community consultation raised queries as to what would happen to this infrastructure and new housing supply once the project complete, and whether that accommodation and infrastructure could be repurposed or integrated into the existing community (such as for seasonal workers or visitors).
- Concerns were also raised about what effect additional housing and infrastructure could have on existing property values and rates.
- A short-term increase in workforce and population may put pressure on community services such as schools, healthcare and business such as retail. Similarly, once the project is complete, the community raised concerns around how these services would cater for a potential decrease in demand and how new facilities are funded and managed into the future.
- A rapid influx of people and the potential change in community cohesion and social connection, could see increased rates of crime and social problems. Some community members were concerned that if this occurred it could affect the attractiveness of the area for retirement living, remote workers and workers in sectors other than construction.

9.3.5 Impacts on mana whenua

The project would result in the loss of a number of features within the project area which are of particular significance to mana whenua, including wetlands. These features, and the reasons for their significance to mana whenua, are set out in the Cultural Values Statement provided by Aukaha and are summarised in **Chapter 4: Cultural**.

As also discussed in that Statement and Chapter, should it proceed, there are likely to be wide-ranging economic and employment benefits associated with the project. In that context, mana whenua considers that it is vital for these benefits to be distributed equitably across the whole community, not just in employment, but through active engagement in all levels of the activity, including governance.

---

[219] For example, Central Otago District Plan, Schedule 19.4, 259 Horseshoe Bend Bridge.

9.3.6 Summary of impacts

These potential social impacts, and the entities most likely to be affected by them, are summarised in Table 9.1 below.

Table 9.1 Summary of potential social impacts

Potential impact	Who would be affected and likely locations
Stress and anxiety from uncertainty and change during planning and construction	Landowners and farmers, residents, recreational users, and businesses - in the project footprint and Teviot Valley
Loss of farmland, adjustments to farm operations, and reconfiguration of farm enterprises, increased use of local roads	Landowners and farmers, farm families, farm workers and families operating at or close to Lake Onslow, reservoirs or in project footprint
Disruption to irrigation, rural and potable water supplies and small-scale electricity	Farmers, small settlements, councils, irrigation companies, electricity companies and consumers
Loss of wetlands and mahika kai	Mana whenua, regional conservation and recreation groups
Changes to trout habitat and fishing conditions	Anglers (local and regional); hut owners
Flooding of huts, boat ramp and access ways	Hut owners at Lake Onslow, farmers, recreational visitors (local, regional)
Loss of heritage and cultural sites and taonga	Mana whenua, multi-generational farmers and residents, surrounding communities, lake users, visitors
Short-term demand for construction workers and flow on effects on employers and self employed	Regional workers, youth, iwi, contractors, employers; national and international contractors and employers
Temporary demand for construction worker accommodation	Providers of temporary accommodation; Seasonal workers in horticulture and hospitality; Residents renting
Increased local and regional business activity and employment, and demand for services	Employers and workers in multiple sectors, councils, sector organisations
Changes to visitor activity; Physical effects on rivers, cycle and walking trails and recreation access points and sites	Local tour operators and guides, hospitality businesses, workers, visitors
Provision of social and community services	Social, councils, health, police and emergency service staff and clients, families, vulnerable groups
Community change and social cohesion	Residents, workers, councils, community groups and leaders

Source: Adapted from Nick Taylor and Associates. (2022). *Aotearoa/NZ Battery Project – Interim assessment of social impacts for Lake Onslow pumped hydro scheme option*.

9.4 Options to address impacts

Given these potential impacts, the Interim Assessment expresses a preference for design options that have the least disruption and negative impact on existing land holdings and uses such as choosing the lower 3TWh scheme and locating the offtake at s 9(2)(i)

The Interim Assessment also identifies a range of potential initiatives which could be considered as part of remedying, mitigating or offsetting adverse social impacts, and enhancing positive social impacts.

These include:

9.4.1 Establishment of a Social Impact Management Plan (SIMP)

The SIMP should be developed in consultation with the affected communities and would identify strategies and actions to reduce, mitigate or remedy negative social impacts, and enhance positive impacts. It would ideally include a communications strategy, and a complaints and grievance redress mechanism. The SIMP should also outline procedures for monitoring social impacts and ensuring that actions for mitigating and managing social impacts were up-to-date and adjusted as necessary.

9.4.2 Continued engagement and communication

This could include regular meetings and updates that take place at a range of times and locations to reach all members of the community (including other townships within the region that could be affected by the project). Communication would ideally occur through a mix of mediums, such as newsletters, emails and media, and may extend to the establishment of a local information hub and a representative liaison group.

9.4.3 Community benefits

Opportunities should be identified for the project to support key community initiatives and the local economy. Project procurement for labour, goods and service could assist local and regional economics, similar to what is being planned for other large infrastructure projects such as the Dunedin Hospital. A community fund, tied to the long-term income from the project, could be established to benefit the communities most affected by it.

9.5 Information gaps and risks to decision-making

At this current stage, there are not considered to be any material information gaps regarding the potential social impacts of the project, although additional work (described below) will assist in clarifying and confirming those impacts, and identifying options for how they might be addressed for optimal social wellbeing outcomes.

The economic impact of the project for the study area specifically has not been assessed as yet. It is, however, considered unlikely that such information will change the overall conclusion of the Interim Assessment, being that the project will have substantial impacts on communities within the project area – particularly those located within or in closest proximity to, the inundation area.

9.6 Recommended future actions

If the project proceeds, it is recommended that the following further work is undertaken:

- A SIMP is prepared and followed throughout all phases of the project
- A full and comprehensive Social Impact Assessment is undertaken following the requirements and approach set out in the Interim Assessment.

10 Recreation

This section describes the existing recreation values within the project area and the likely impacts of the project on those values. It identifies options which may be available to address or mitigate those impacts; outlines current gaps in technical understanding and provides an assessment of the significance of those information gaps for future decision-making.

This section has been informed by detailed assessments undertaken by Rob Greenway & Associates (RGA), and the Otago Fish & Game Council which are appended in **Volume Two**.[220]

10.1 Baseline recreation values

The existing recreation values of different locations within the project area are summarised below. Generally, these areas are valued because they support or enable sporting, active and other leisure activities for communities. A number of those activities (and their recreation value) are also recognised within the existing legislative and regulatory framework (as described in **Chapter 18: Legislative context**).

The relative significance of those values at a regional level (as determined by RGA) is summarised in Table 10.2 below.

10.1.1 Lake Onslow

The RGA report outlines that Lake Onslow and its immediate surrounds are recognised for a number of recreation attributes, the most significant of which is recreational fishing, with the popularity of that activity driven by the following features:

- The Lake has very high numbers of brown trout mostly due to the ideal spawning habitat provided by the five tributaries to the Lake. NZ Fish & Game data show that the peak fishing time is between December and March, although fishing does take place throughout the year, even with winter road conditions
- The Onslow cicada hatch between January and February is renowned by trout fishing clubs due to cicada being a food source for trout[221]
- There is a high bag limit of 10 fish per day (the highest in the South Island, with bag limits predominantly two in most other South Island locations)
- There are approximately 17 privately or club-owned angling huts on private land (or on the marginal strip) surrounding Lake Onslow, two of which are routinely advertised for hire to club members by the Teviot Angling Cub. Club competitions and fishing research are held annually
- Good access to angling spots around the Lake is provided via access easements or over private land. A boat ramp is present near the main huts on the west side of the Lake and can be accessed via private roads (with permission from landowners)
- Angling also occurs on the tributaries to Lake Onslow and Te Awa Makarara/Teviot River
- The Lake is also used for recreational freshwater crayfish (kōura) take (although this has not been assessed).

[220] Rob Greenway and Associates. (2021). *Lake Onslow – NZ Battery Project Preliminary Recreation Values Assessment*; Rob Greenaway & Associates. (2022). *Aotearoa/New Zealand Battery Project Recreation Values Assessment*.

[221] Note that NIWA has undertaken preliminary surveys into the food sources for trout in Lake Onslow, but further work is required to determine the significance of terrestrial invertebrates such as cicada as a food source for trout.

In addition, in interviews conducted by RGA, recreational lake fishers consistently highlight the Lake's productivity for trout, the ease of access, and the surrounding scenery as qualities which underpin its value as an angling location. In light of all of these factors, RGA concludes that, when viewed at a regional level, angling at Lake Onslow has a **very high** recreation value, and is unique given the high bag limit. Angling on the tributaries and at the Diggings (a small group of ponds located off Lake Onslow Road on private land) is recorded as being of low value, while angling on the Te Awa Makarara/Teviot River is of moderate value.

In addition to fishing, Lake Onslow is used for recreational boating, swimming and picnicking. As noted above, boat access is from the west side of the Lake, near the privately-owned angling huts. The Lake Onslow Road is used by cyclists, often as an opportunity to ride an almost complete loop formed by the Otago Central Rail Trail and the Clutha Gold Trail. The Lake Onslow Road is also identified as a recreational four-wheel drive route, with online references describing it as appropriate for casual on-road motor biking. While not as popular, walkers and hikers also use the Lake Onslow area for exploration. Hunting of wildfowl on Lake Onslow has also been reported (including Canadian geese, mallards and paradise shelduck) and the adjacent Manorburn Conservation Area is a popular area for hunting pigs and red deer.

In its assessment, RGA concludes that, when viewed at a regional level, the recreation value of these other activities at or around the Lake are high (cycling and sightseeing) and moderate (all others).

10.1.2 Lake Roxburgh

s 9(2)(i) [redacted] Lake Roxburgh has also been assessed for its recreation value. As the least-used major waterbody in the Mata-Au/Clutha River catchment, Lake Roxburgh's most important recreation value is the recently developed 11km ferry that travels through the Roxburgh Gorge to transport cyclists (mostly) and walkers on the Roxburgh Gorge Walking and Cycle Trail. The Roxburgh Gorge Cycle and Walking Trail is on an easement over private land along the west bank of the Lake and over 20,000 uses of the Trail were estimated in the year ending February 2020. The ferry is serviced by two commercial boat operators during the summer season and can be accessed from 7km upstream of Roxburgh Dam.

The RGA report notes a recent increase in fishing in Lake Roxburgh due to the additional publicity generated through nearby walking and cycling trails. Three species of salmonid as well as perch are known to reside within the Lake. Boat access to the Lake is obtained from a public boat ramp near the Roxburgh Dam or from Alexandra. Jet Boating New Zealand has secured an increase from the Otago Regional Council of the 5-knot navigation safety rule to allow boating at greater speeds on the Lake.

Taking these features into account, RGA concludes that the recreation value of the cycling facilities at Lake Roxburgh is very high at a regional level, while boating and angling is assessed as having moderate recreation values.

10.1.3 s 9(2)(i) [redacted]

[redacted]

[redacted]

[redacted]

When viewed at a regional level, the recreation value of these areas for both their cycling and angling activities is considered to be very high.

10.1.4 Lower Mata-Au/Clutha River

The lower Mata-au/Clutha River is popular for kayaking, jet boating, rafting, whitebaiting, wildfowl hunting and trout and salmon angling. Camping, cycling and walking are also popular along the river margins, with the Clutha Gold Trail running from Roxburgh Village to Beaumont on the east side of the river. This Trail had an estimated 10,500 users in the year ended February 2020.[222]

There are boat launching ramps located at Balclutha, Kaitangata and Clydevale providing access to the Lower Mata-Au/Clutha River. In addition, the Tuapeka Mouth Ferry ('the punt') operates from two floating pontoons at Tuapeka Mouth for two hours in the morning and evening. Use of the punt is growing in popularity, with local farmers operating run-off blocks on either side of the River using it at least once a day. The operation of the punt is influenced by river flows and therefore operators are in direct contact with Contact Energy (operators of the Roxburgh Dam) to ensure the safe operation of the punt. There is very little, if any, commercial jet boating on the Mata-Au/Clutha River.

The lower Mata-Au/Clutha River is also used as a significant education resource for training in white-water activities (kayaking and rafting), as well as river safety training.

Contact Energy administers a Sports and Fish Management Plan for the lower Mata-Au/Clutha River in consultation with the Otago Fish & Game Council. This management has historically included a release of smolt salmon near the Roxburgh Dam. It is understood that Contact Energy and Otago Fish & Game are exploring the potential establishment of a trust with a broader conservation and habitat restoration focus.[223]

Angling targets in the lower Mata-Au/Clutha River include salmon, trout and perch, but most salmon fishing occurs at the Roxburgh Dam (which is the upriver limit for migrating fish). Anglers report better fishing during low flows of the river when there is better and safer river-side access. The river mouth on both the Matau and Koau Branches of the Mata-Au/Clutha River provides the most popular white-baiting setting in the region.

Overall, RGA concludes that that the recreation values of the lower Mata-Au/Clutha River are very high for the Clutha Gold Cycle Trail facilities, angling and the operation of the Tuapeka Mouth Ferry. White water activities have been assessed as having moderate recreation values. As the only location for such activities in the region, the recreation value of the existing whitebaiting activities is assessed as high.

10.1.5 Conclusion on baseline values

The relative significance of these baseline recreation values when viewed in a regional context are illustrated in Table 10.1 below.

Table 10.1: Recreation values at a regional level

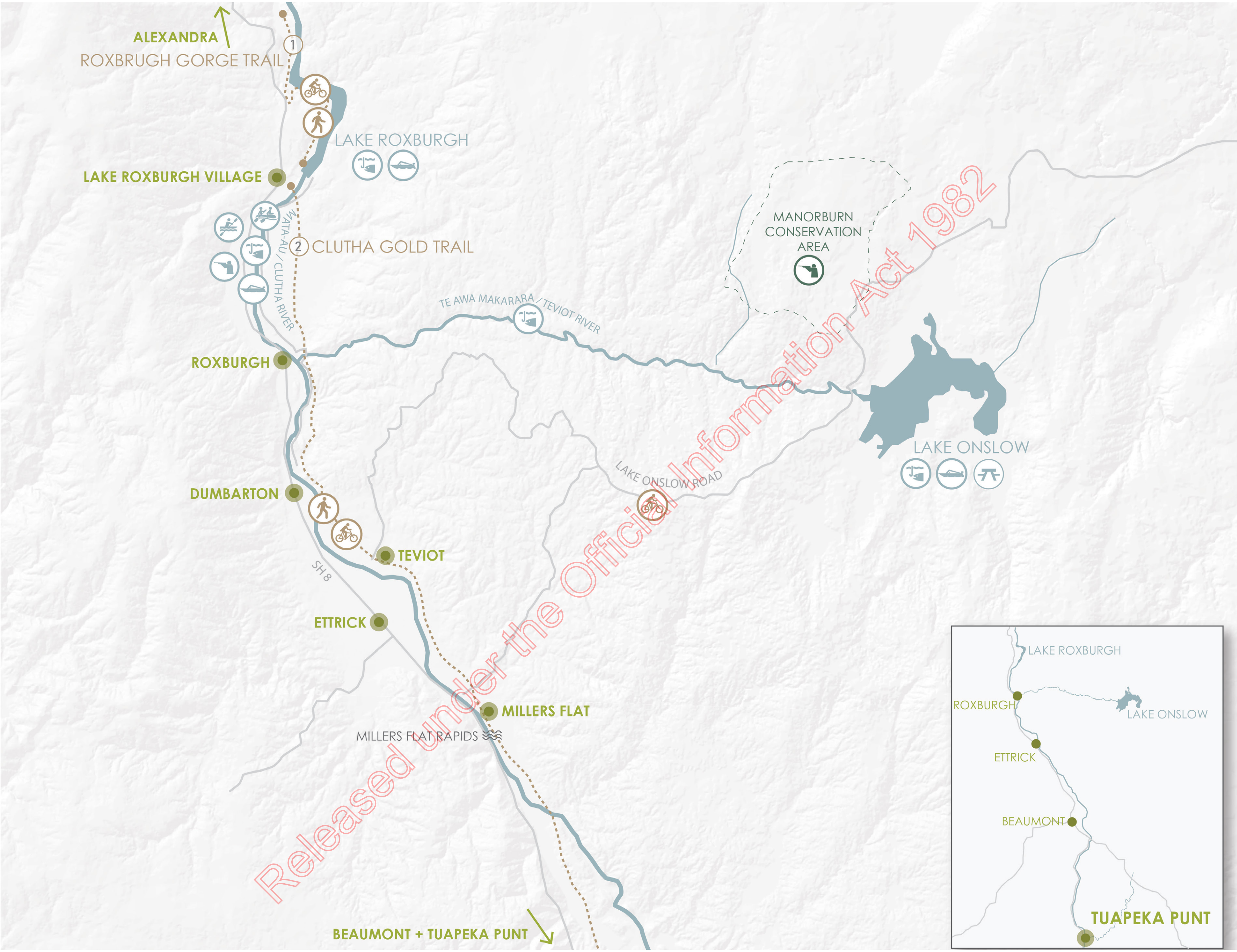
Very High	High	Moderate	Low
Angling at Lake Onslow – unique due to high bag limit	Cycling Lake Onslow Road	Angling on the Te Awa Makarara/Teviot River	Angling on Lake Onslow tributaries

[222] Rob Greenaway & Associates. (2022). *Aotearoa/New Zealand Battery Project Recreation Values*, page 37

[223] Rob Greenaway & Associates. (2022). *Aotearoa/New Zealand Battery Project Recreation Values*

Very High	High	Moderate	Low
Cycling on the Roxburgh Gorge Trail	Sightseeing from local roads around Lake Onslow	Boating on Lake Onslow	Sightseeing and fishing at The Diggings
Cycling on the Clutha Gold Gorge Trail	Whitewater activities on the Mata-Au/Clutha River	Hunting in the Manorburn Conservation Area	
Angling on the Mata-Au/Clutha River	Whitebaiting in the Clutha River	Hunting on and around Lake Onslow	
Operation of the Tuapeka Mouth Ferry		Four-wheel driving near Lake Onslow and Manorburn Conservation Area	
		Picnicking and swimming at Lake Onslow	
		Boating and angling on Lake Roxburgh	

Source: Rob Greenaway & Associates. (2022). *Aotearoa/New Zealand Battery Project Recreation Values*



NTS: Diagram intended for schematic/illustrative use only

N

TE RŌPŪ MATATAU
CONNECTED IN THINKING AND ACTION

Legend
- Existing Lakes and Rivers
- Existing Tributaries
- Lake Onslow Road
- 1 Roxbrugh Gorge Trail
- 2 Clutha Gold Trail

Ministry of Business, Innovation & Employment
NZ Battery Project: Lake Onslow Pumped Hydro Storage Option

10.1 Recreation values within the project area

File Ref: BM210219_Values_Diagrams_Titleblock.indd
Print date: 01 Sept 2022

Reviewed: DRo
Created by: EFa

10.2 Impacts of project on baseline values

RGA has undertaken a preliminary assessment of the extent to which the project would adversely impact on the recreation attributes of these locations within the project area, if no mitigation was provided.[224] That assessment takes account of the relative recreation value of the feature, and the magnitude of effect according to the following table.

Table 10.2: Scale of impact on creation values considering magnitude of effect

		Recreation value			
		Very High	**High**	**Moderate**	**Low**
Magnitude of effect	**High or severe**	Significant	Significant	Moderate	Minor
	Moderate or medium	Significant	Moderate	Minor	Minor
	Low or minor	Moderate	Moderate	Minor	Minor
	Negligible	Negligible	Negligible	Negligible	Negligible

Source: Rob Greenaway & Associates. (2022). *Aotearoa/New Zealand Battery Project Recreation Values*

The findings of that assessment are illustrated in Table 10.3, and are described in more detail in the following subsection.

Table 10.3 Scale of (unmitigated) effects on recreation values at a regional level

Significant[225]	**Moderate**[226]	**Minor**[227]
Lake Onslow		
• Angling at Lake Onslow • Cycling Lake Onslow Road • Four-wheel driving near Lake Onslow and Manorburn Conservation Area • Sightseeing from local roads	• Boating on Lake Onslow • Picnicking and swimming at Lake Onslow • Hunting on and around Lake Onslow	• Angling on the Te Awa Makarara/Teviot River • Hunting in the Manorburn Conservation Area • Fishing and sightseeing at The Diggings

s 9(2)(i)

[224] The assessment is considered preliminary because many of the operational aspects of the project have not been finalised, such as the flow regime in the Mata-Au/Clutha River, and the operation of the upper reservoir.

[225] According to RGA, a "significant" adverse effect, according to RGA, would likely displace many or most users from a setting for a prolonged period (though not necessarily all activities). It is however likely that the amenity for all activities would be degraded.

[226] According to RGA, a "moderate" adverse will periodically displace some activities and users, but amenity will not be degraded for all activities.

[227] According to RGA, a "minor" adverse effect will displace a small number of users for short periods, but amenity will almost always be preserved for the majority of activities and users.

Significant[225]	**Moderate**[226]	**Minor**[227]
s 9(2)(i)		
Lower Mata-Au/Clutha River		
• Nil	• Angling • Operation of the Tuapeka Mouth Ferry • Whitewater activities	

Source: Rob Greenaway & Associates. (2022). *Aotearoa/New Zealand Battery Project Recreation Values*

10.2.1 Lake Onslow

The most significant adverse impacts of the project on recreation values will be experienced at Lake Onslow, and, in particular, on the Lake's recreational attributes as an angling destination, and a location for cycling, four-wheel driving and sightseeing.

Those adverse impacts primarily arise through the inundation of the Lake to create the upper reservoir and through the Lake level fluctuations. Under both inundation options assessed (3TWh (745mRL) and 5TWh (765mRL)), all existing marginal strips and access easements around the Lake and its tributaries would be inundated, apart from those adjacent to the upper reach of the South Branch of the Te Awa Makarara/Teviot River and the Te Awa Makarara/Teviot River below the proposed dam. Part of the Lake Onslow Road would also be inundated, as well as the north-eastern corner of the Manorburn Conservation Area. The implications of this for the recreation values attributable to the Lake are discussed in further detail below.

10.2.1.1 Angling

The impacts of inundation (under both options) on trout habitat have the potential to significantly impact the angling value of Lake Onslow as almost all trout spawning habitat would be lost with the creation of the upper reservoir. In particular, analysis undertaken by the Otago Fish & Game Council suggests that, if the Lake level is increased to 765mRL (5TWh option), almost all of the trout spawning habitat would be lost (with only around 0.34% remaining), which will significantly impact the productivity of trout within the Lake.[228]

The extent of this impact will, however, ultimately depend on:

- The capacity of the remaining tributaries of the upper reservoir to operate as a high-productivity spawning habitat
- The capacity of the upper reservoir to support high numbers of adult trout
- The operating regime in terms of frequency, rate, timing and scale of drawdown.

In addition to the effects on these habitats, the following outcomes of inundating the Lake are likely to adversely impact its value for recreational fishing:

- Loss of all private angling huts and the boat ramp (mostly located on private land)

228 Otago Fish & Game Council. (2022). *An Investigation into Lake Onslow Brown Trout Spawning Habitat Availability at Increased Lake Heights*

- Loss of access to and along the foreshore of Lake Onslow and the uppermost reach of the Te Awa Makarara/Teviot River due to the inundation of marginal strips and public access easements. It is however noted that access to these areas for angling purposes may become less valued if the Lake itself is less productive for trout.
- Difficulty in maintaining access to the water due to the large horizontal differences between the shorelines at full supply level and the minimum operating levels.
- Effects on landscape values would also affect the future quality of these activities, and during dry years significant areas of exposed reservoir bed would have effects on visual amenity (refer to **Chapter 8: Natural character, features and landscapes**).

Taking these factors into account, RGA concludes that, without mitigation, the project could potentially have significant adverse effects on the recreation attributes of the Lake as an angling destination.

10.2.1.2 Cycling, four-wheel driving, sight-seeing and other recreation activities

The proposed inundation of the Lake will result in the loss of connection and/or severance of public access to a range of locations around the Lake which currently support these recreation activities. In particular:

- Loss of connection on Lake Onslow Road from east to west (caused by severance through inundation), affecting four-wheel driving, drive touring generally and cycling and walking access to the Manorburn Conservation Area.
- As noted above, walking access to and along the existing foreshore of Lake Onslow and the uppermost reach of the Te Awa Makarara/Teviot River will be lost due to the inundation of marginal strips and public access easements.
- The inundation of the northeast corner of the Manorburn Conservation Area will affect hunting and angling.
- The inundation of the existing foreshore and area around Lake Onslow would adversely affect its value as a hunting location, and as a spot for picnicking and swimming.
- Two small Central Otago District Council reserves near the existing dam will be lost.
- The Diggings – currently a minor local visitor destination located on private land – will also be inundated.
- Access to the Lake for boating will be lost.
- Effects of the project on landscape values would also affect the future quality of these activities (refer to **Chapter 8: Natural character, features and landscapes**).

In RGA's assessment, without mitigation, the adverse effects of the project on cycling, four-wheel driving and sightseeing from roads in the area surrounding the existing Lake have the potential to be significant. For all other activities, those potential effects are likely to be moderate or minor.

10.2.2 s 9(2)(i) [redacted]

[redacted]

[redacted]

s 9(2)(i) [redacted]

[redacted].

10.2.3 s 9(2)(i) [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

10.2.4 Lower Mata-Au/Clutha River

The project may result in significantly greater variability in flows of the lower Mata-Au/Clutha River under all three of the offtake scenarios.

In particular, persistent periods of reduced flows in the lower Mata-Au/Clutha River as the upper reservoir is filled may have:

- Positive impacts on angling by exposing river gravels and making access to fishing water easier.
- Positive impacts on white-water activities by exposing white-water features.
- Negative impacts on the Tuapeka Mouth Ferry by increasing the period of flows below 300 m^3/s when it is too low to accommodate the ramps for some vehicles, and increase in the period when coinciding low flows (<300m^3/s) and strong winds can cause the punt to become stuck on one side of the River; at present this occurs infrequently.

Increased flows of the lower Mata-Au/Clutha River when the project is generating may have:

- Adverse impacts on angling (by drowning beaches and making access difficult) and on white-water activities (by covering white water features).
- Negative impacts on the Tuapeka Mouth Ferry by increasing the period that the River exceeds 800m^3/s when the ramp becomes too steep to access.
- Positive impacts for the Ferry by reducing the potential for low flows and high winds stranding the punt.

Alongside these effects, the unpredictable variability in flows of the lower Mata-Au/Clutha River would also have a general adverse effect by limiting river users' ability to predict the River's suitability for their activity. Flow variability is an expected existing element of the lower Mata-Au/Clutha River recreation experience, although it follows a reasonably predictable daily generation pattern. The scale of the potential impact would depend on the management of the discharge and take regime, and its interaction with the existing operating regime from Roxburgh Dam.

In summary, this variability (caused by the discharge and take of water from the River for the project) has the potential to range in scale of effect on recreation attributes from moderate to minor. It is, however, unlikely to be significant, considering the existing scale of flow variability.

10.3 Options to address impacts

RGA have identified the following options which may assist in addressing those potential adverse impacts of the project on recreation values of the project area that have been outlined above:

- The provision of alternative road access to Lake Onslow, both during construction and once the project is operational, would mitigate the loss of access to the Lake and provide options for cycling, four-wheel driving, and sightseeing.
- Relocating the angling huts (noting that their value for supporting angling activity at the new reservoir may be limited if the Lake does not support trout habitat).
- Retaining access and the use of the upper reservoir for fishing, boating, swimming and picnicking would avoid or at least mitigate the loss of those values at Lake Onslow. However, the ability to carry out these activities would depend on safety, lake levels and how frequently drawdown occurs.
- Moving the s 9(2)(i) [redacted] offtake location 200m downstream to avoid the existing gravel beach area, would avoid impacts on the beach likely to be used for angling.
- Imposing a controlled discharge ramping rate for the lower Mata-Au/Clutha River to ensure river users' safety is not compromised by significant and unpredictable discharge events.
- As per the current operation of the Roxburgh Dam, making information available to river users about the flow patterns to mitigate potential impacts from flow changes.
- s 9(2)(i) [redacted]
- Rerouting the Clutha Gold Trail around any offtake structure.
- Designing any offtake structure to ensure safe passage past for boaters, kayakers and other river users, and installing fish screens to minimise the loss of adult sports fish.

As set out in **Chapter 5: Freshwater,** Fish & Game New Zealand and Wildlands have considered how impacts of the project on recreational fishing within Lake Onslow might be addressed. Both organisations identify enhancement of other recreational fishing sites as a possible option, as there is an abundance of prior knowledge and experience with such enhancements, and the chances of achieving successful off-setting is high.

Those options for enhancement fall into two categories:

- Improving built facilities in other identified recreational fishing locations, including access roads, parking areas, boat ramps, toilets, jetties, tracks, fish cleaning stations and landscaping
- Improving trout stocks and condition in those locations.

10.4 Information gaps and risks to decision-making

RGA have identified a range of assumptions and information gaps in their assessment as set out below. In our opinion, those gaps do not present a significant risk to the decision to progress further work.

The potential loss or significant reduction of a regionally significant recreational fishing resource is an expected impact of the project. That conclusion is supported by the analysis completed by Otago Fish & Game Council, and that loss will have commensurate impacts on the social wellbeing of the community that enjoys those activities. Further technical analysis is required to confirm whether mitigation options are available, and these will need to be considered as the design of the project progresses.

10.5 Recommended future action

If the project proceeds, it is recommended that all of the following actions are taken to improve understanding of the potential impacts of the project on recreation values:

- Complete additional consultation with the local community to improve understanding of existing recreation values within the area.
- Confirm whether the upper reservoir (with its water level fluctuations) can support trout habitat (refer to **Chapter 7: Indigenous biodiversity**).
- Confirm whether the variability in flows of the Mata-Au/Clutha River can be controlled to avoid rapid changes in river levels.
- Complete assessment of impacts on Lake Onslow's kōura population, which has recreation significance.
- Complete assessment of impacts on whitebait habitat which has recreation significance downstream in the lower reaches of the Mata-Au/Clutha River.
- Identify opportunities to enhance recreation outcomes.

11 Heritage

Within the project area, there are a range of recorded sites and features which have heritage and archaeological value, and which fall within the definition of historic heritage[229] and archaeological sites[230] within the existing statutory framework.

This section provides an overview of those features, based on the information available, including two assessments undertaken by New Zealand Heritage Properties Limited (NZHP) (available at **Appendix I.1 and I.2 in Volume Two**) in respect of the project area, and outlines the components of the project which could adversely affect these values.

As described further below, archaeological and cultural sites of significance to mana whenua form a critical part of the heritage values within the project area. Those sites and the reasons for their significance are described in the Cultural Values Statement prepared by Aukaha and are also addressed in the context of the project in **Chapter 4: Cultural.**[231]

11.1 Historical context

The historical occupation of the project area (including Lake Onslow, the Mata-Au/Clutha River, and the potential in-take locations at s 9(2)(i)) is set out in detail in the NZHP report and is summarised below.

11.1.1 Historical occupation of Lake Onslow and its surrounds

The history of Lake Onslow traces several key periods of occupation, from the seasonal nohoaka (*a place to sit/rest*) of early Māori communities through to the occupation of European pastoralists, miners and populations associated with emerging townships.

Settlement patterns in Central Otago indicate that the wider area was used by early Māori for migratory routes, seasonal hunting, fishing and to maintain long-distance trade networks.[232] These accords with current archaeological evidence in and around the current Lake Onslow (described below) which illustrate its historic value for:

- Mahika kai (*traditional food gathering site*) | Evidence exists that earliest Māori groups took advantage of abundant moa, waterfowl, freshwater species, tuna and small birds in areas such as Lake Onslow (formerly Dismal Swamp) and its tributaries, and Fortification Creek wetland complex.
- Mahika toi (*traditional non-food gathering site*) | Silcrete and porcellanite (*rock*) raw materials were particularly important during early periods of Māori settlement. Evidence of both have been found at archaeological sites near Lake Onslow.
- Ara tawhito (*traditional travel routes*) and nohoaka | Ara Tawhito over land and along rivers in the region were utilised to access important food and material resources, providing

[229] 'Historic heritage' in terms of the Resource Management Act 1991 captures natural and physical resources that contribute to an understanding and appreciation of New Zealand's history and cultures deriving from a range of qualities including archaeology, architecture, culture and technology.

[230] Under the Heritage New Zealand Pouhere Taonga Act 2014, an 'archaeological site' includes any building or structure, or part of a building or structure, that was associated with human activity that occurred before 1900 and any site **that** provides or may provide (through investigation by archaeological methods) evidence relating to the history of New Zealand.

[231] Aukaha (1997) Limited. (2021). *Cultural Values Statement: The Lake Onslow option for the New Zealand Battery Project*

[232] New Zealand Heritage Properties Limited. (2022). *Lake Onslow Hydro Storage Project A Desktop Assessment of Archaeology and Heritage,* page 17.

opportunities for trade, and travel between established communities. The Mata-Au/Clutha River was a particularly important traditional routeway, providing connections to the Otago Lakes and the interior of the region, often through the tributaries, including the Te Awa Makarara/Teviot River. The area in and around Lake Onslow provided a food source and supported seasonal nohoaka, with evidence of moa bone butchering, stone working and small fires.

The 'contact' and 'post-contact' period between Māori and Pākehā brought new occupations and activities to the area. Pākehā explorers, in some cases led by Māori guides, came through the area, mostly looking for land to claim for farming. During the late 1850s, two primary runs within the project area were established: Teviot Station (John Cargill) and Oven Hills (Walter Miller). By the 1860s, the gold rush took hold of the region, leading to the construction of water races (which led to the damming of Dismal Swamp to form Lake Onslow in 1890), and the adoption of various other mining methods and technologies such as sluicing and hydraulic elevators. By the mid-1920s, the primary use of water within the Lake had shifted to electricity power generation, and fishing.

11.1.2 s 9(2)(i) [redacted]

[redacted]. Evidence that has been uncovered, however, indicates that Māori presence in these areas was also focused on travel as a result of trade networks established between the east and west coasts, as well as for seasonal hunting, fishing and resource collection. It particularly highlights the following activities/values:

- Mahika kai | The Mata-Au/Clutha River was an important source of freshwater fish and bird life, and several species of both types were traditionally harvested from the river.
- Ara tawhito (*traditional travel routes*) and nohoaka | The significance of the Mata-Au/Clutha River as an ara tawhito is described above and in the Cultural Values Statement. Several recorded archaeological sites along its banks are indicative of seasonal nohoaka used by groups as they travelled along the river.

Like Lake Onslow, the 'contact' and 'post-contact' period saw the introduction and expansion of pastoral, and later, mining, activities around the proposed offtake areas at s 9(2)(i) [redacted], s 9(2)(i) [redacted] The damming of Lake Roxburgh in the 1940s resulted in the submergence of that part of the Mata-Au/Clutha River's shoreline, and with it, many of the archaeological sites and features along that section of the River were also submerged. Historically, s 9(2)(i) [redacted] was notable for its development in the 1860s s 9(2)(i) [redacted] Evidence of these activities remain within the proposed offtake area. Evidence of early, seasonal Māori occupation has also been identified at s 9(2)(i) [redacted] which was similarly used at later stages for s 9(2)(i) [redacted]

11.2 Baseline archaeological and heritage characteristics within the project area

As set out further below, NZHP has identified a range of archaeological and heritage sites within the project area and has assessed the significance of their values using specific criteria. Those criteria are set out in full in the NZHP assessments, but in brief, they consider:

- The specific features of the site, including its condition, rarity, contextual value, information potential, amenity value and cultural associations.
- The archaeological significance of that site (taking account of those features) – the relevant levels of significance are described in Table 11.1 below.

- The assessment undertaken by NZHP is based on a desktop study of information from a variety of documentary sources, including records held by the New Zealand Archaeological Association, Heritage New Zealand Pouhere Taonga, local authorities, and the Kā Huru Manu Atlas[233].

Table 11.1: Levels of overall archaeological significance

Level of significance	Criteria
Very high	World Heritage Sites (and proposed sites) • An archaeological site of acknowledged international importance
High	Listed archaeological sites, including those of listing quality and importance: • Category 1: places of special or outstanding historical or cultural heritage significance or value • Category 2: places of historic or cultural heritage significance or value • Scheduled archaeological sites, including those of scheduling quality and importance • Archaeological sites with exceptional values
Medium	Archaeological sites that can be shown to have moderate values
Low	Archaeological sites with limited value, including those that are highly represented, have low information potential, have poor preservation, and/or poor survival or contextual association
Negligible	Assets with very little surviving archaeological interest
Unknown	The importance of the site is not yet known

Source: Adapted from New Zealand Heritage Properties Limited. (2022). *Lake Onslow Hydro Storage Project A Desktop Assessment of Archaeology and Heritage,* page 17.

11.2.1 Lake Onslow and its surrounds

There are eight recorded archaeological sites within the project area surrounding Lake Onslow, and six sites within 1km of the project area. The recorded archaeological sites are identified in Table 11.2 and depicted on Figure 11.1.

Of these sites, one is identified as having **high** archaeological value (G43/9). This site is a midden/oven site (consisting of seven schist ovens, porcellanite flakes and possible in-situ moa bone fragments) located in the southwestern corner of Lake Onslow and is the only heritage site entered on the Heritage New Zealand List/Rārangi Korero within the project area. It is listed as a Category 2 Historic Place[234] on that List and scheduled as a historic place in Schedule 19 of the Central Otago District Plan. According to NZHP, the site was initially recorded in its identified location in 1973, but when the site was revisited in 1977, the ovens could not be found (although burnt schist and bones tentatively identified as moa were noted). The site record has not been updated since 1978 and it is possible that this site is now submerged within the Lake or is located on its margins.

Alongside G43/9, five of the other seven recorded archaeological sites within the project area were assessed by NZHP as having medium archaeological value, with the balance having low archaeological value. A further recorded site, located just south of the project area within Fortification Creek wetland complex, is assessed as having medium archaeological value. Those sites are described in Table 11.2 below.

[233] Many of the sites described have not been visited since the 1970s. It is therefore possible that since that time, some of the sites are now completely submerged. As the condition of such sites is important to an assessment of its value, conclusions regarding these values could be subject to change if and when physical investigations are undertaken.

[234] New Zealand Historic Places Trust does not hold an electronic or hard copy file on this listing.

Table 11.2 Archaeological values within or near the inundation area of Lake Onslow

Site Reference	Type	Brief description	Location
G43/9[235] New Zealand Heritage List/ Rārangi Korero; CODC Plan	Midden/oven	The site has previously been recorded as consisting of ovens, flakes and possible in situ moa bone fragments. Some material was collected and is held at Otago Museum. Located on the southwest margin of Lake Onslow. Considered to have **high** archaeological values. Included on New Zealand Heritage List/Rārangi Korero as a Category 2 Historic Place (list no. 5623). Listed in CODC Plan[236] register of heritage buildings, places, sites and objects (no 286).	Within project area, possibly submerged
G43/39	Working area	The site consists of moa bone, possible gizzard stones and flaked dark red – brown porcellanite. This indicates a site of possible moa butchering. The site is located on the south west edge of Lake Onslow. Considered to have **medium** archaeological values.	Within project area; possibly partially submerged
G43/40	Unclassified	The site was recorded as a schist chimney from a hut which is believed to be a shepherd's hut associated with Teviot Station. The site is located on the eastern margins of Lake Onslow, along the Te Awa Makarara/Teviot River. Considered to have **medium** archaeological values.	Within project area
G43/43	Cave/rock shelter	The site consists of a small shelter formed by a schist overhang. There is a historic fireplace and drystone walling. This rock shelter has been modified for the construction of a historic shelter. There is limited information on this site, and it may relate to gold mining activity or associated with Linburn Station. The site is located on the northern margin of Lake Onslow. Considered to have **medium** archaeological values.	Within project area
G43/192	Midden/oven	The site consists of a circular pit that has been identified as a potential umu (oven). The site is located to the south of Lake Onslow along Boundary Creek. Considered to have **medium** archaeological values.	Within project area
G43/198	Mining - gold	Two hut sites, gold sluicing, and a small water race. The site is located to the southeast of Lake Onslow along the south branch of the Te Awa Makarara/Teviot River. Considered to have **medium** archaeological values.	Within project area
G43/202	Mining - gold	The site consists of a gold mining complex that includes a hut, water race, hydraulic excavation and prospecting pits. The description of the site suggests that some features may extend into the 800m contour. The LIDAR review identified features along Fortification Creek wetland complex. Considered to have **medium** archaeological values.	<1km from inundation area
G43/42	Mining - gold	The site consists of sluice workings near the Te Awa Makarara/Teviot River North Branch within Teviot Station (Run 199). Historical research indicates that the site was also associated with pre 1880s water races and at least one hut (Falconer's). The LIDAR review shows associated water races along the Te Awa Makarara/Teviot River North Branch and features. Considered to have **low** archaeological values (**medium** if hut or race confirmed).	Within project area

235 See 'Other Recognised Heritage Values' section of this table

236 Central Otago District Council. (2008). *Central Otago District Plan*, Schedule 19.4

Site Reference	Type	Brief description	Location
G43/47	Food source	The site appears to encompass the entire Lake Onslow and its associated tributaries as a location of important food resources. Considered to have **low** archaeological values.	Within project area

Source: Adapted from New Zealand Heritage Properties Limited. (2022). *Lake Onslow Hydro Storage Project A Desktop Assessment of Archaeology and Heritage*

In addition to these recorded sites, a number of other archaeological sites adjoining the project area were identified by NZHP in its assessment, along with other geographical and physical features in the surrounding area which have been identified through LIDAR and other data review as having potential archaeological value.[237]

[237] New Zealand Heritage Properties Limited. (2022). *Lake Onslow Hydro Storage Project A Desktop Assessment of Archaeology and Heritage*

s 9(2)(i)

11.2.2 Offtake options

There are no heritage sites listed on the New Zealand Heritage List/Rārangi Kōrero or scheduled on the Central Otago District Plan for any of the immediate three offtake option areas. In addition, as shown on Figure 17.2 below, only s 9(2)(i) [redacted] have any recorded archaeological and heritage sites.

The proposed s 9(2)(i) [redacted] offtake options intersect with the Mata-Au/Clutha River statutory acknowledgment area and areas of public conservation land associated with the marginal strips of the Mata-Au/Clutha River, managed by the DOC and as set out in the **Chapter 4: Cultural**. The Mata-Au/Clutha River is a treasured waterbody for mana whenua and contains along its margins and foreshore a large number of sites which are of significance for Māori, and later goldmining and occupation sites.

s 9(2)(i)

11.2.2.1 s 9(2)(i) [redacted]

Most archaeological and heritage sites near the s 9(2)(i) [redacted] offtake option s 9(2)(i) [redacted]. The only potential remaining site is a s 9(2)(i) [redacted], and which may remain within the project area although this requires verification through an archaeological site survey. There are two archaeological sites recorded within 1km of the proposed s 9(2)(i) [redacted] offtake area as shown in Figure 11.2 and described in the NZHP assessment.

11.2.2.2 s 9(2)(i) [redacted]

Four recorded archaeological sites are located within the s 9(2)(i) [redacted] offtake area. s 9(2)(i) [redacted][238].

Of those four sites recorded within the offtake area, one site is identified as having **high** archaeological values and three as having medium archaeological values as outlined in the table below.

s 9(2)(i) [redacted]

[238] s 9(2)(i) [redacted]

s 9(2)(i)

[redacted]

11.3 Impact of project on the baseline characteristics

11.3.1 Lake Onslow inundation area

- Eight recorded archaeological sites within the inundation area, including one assessed as having 'high' significance, would be destroyed as a result of the proposed expansion of Lake Onslow.
- An additional six recorded archaeological sites within 1km of the inundation area[240] may be adversely impacted as a result of changes in lake water levels (which can cause erosion which in itself may affect archaeological sites) or due to the actual physical spatial extent of these sites.

[239] New Zealand Heritage Properties Limited. (2022). *Lake Onslow Battery Intake Options - A Statement of Archaeological and Heritage Resources*

[240] Sites within 1km of the inundation area should be considered as (i) changes in lake water levels can lead to erosion which may affect archaeological sites; and (ii) archaeological sites (as shown on records) exist as single points on maps, where in fact their actual spatial extent can be more extensive, and in many cases might not be fully understood/known.

Other unrecorded archaeological sites (including those identified through desktop research) may also be disturbed or inundated.

11.3.2 Offtake options

s 9(2)(i)

11.5 Information gaps and risks to decision-making

The NZHP assessments are desktop studies only, and while they draw on an extensive range of sources and have been supported by engagement with Aukaha and other parties including Heritage New Zealand Pouhere Taonga, there are gaps in the information regarding the archaeological and historical values within the project area. In particular:

- It is not known whether there are any physical remains associated with some sites.
- There are likely to be other undocumented archaeological sites across the project area.
- Recorded archaeological sites are often represented as single points in ArchSite (the Aotearoa New Zealand Archaeological Association's national site recording scheme), where

in fact, their actual spatial extent can be more extensive, and in many cases, might not be fully understood/known.

- The baseline assessments undertaken considered only the inundation and offtake areas. Ancillary infrastructure including pipelines and associated earthworks and stockpile areas were not assessed. Further investigative work would be required in this regard.

It is not considered that these information gaps add significant risk to decision-making as to whether to proceed with the project. However, the range of recorded heritage and archaeological sites within the project area already indicate that the project will have adverse effects on heritage and archaeological values of these sites, including the inundation of a site that is currently assessed as having high archaeological significance, and a number of sites which have medium significance.

11.6 Recommended future actions

If the project progresses, the following work is recommended in order to confirm the potential impacts on heritage and archaeological values within the project area:

- A broad pedestrian survey, preferably during dry summer months, of the entire project area (including any affected areas outside of that immediate boundary) is required to ascertain whether any physical remains of sites exist, including a targeted non-invasive survey to document the physical remains of known archaeological sites and areas of interest within the inundation area. More precise information is required on site location, extension, composition, associations, and condition in order to fulfil information requirements associated with the required necessary archaeological authorities. This would include the provision of associated documentation, potential salvage excavation, assessment of effects and recommendations for site management.
- This survey work would be extensive and initially involve a team of archaeologists walking 10-20m transects across the entire project area where ground conditions permit.
- Consultation would also be required with mana whenua, and other affected parties such as landowners (including DOC in conjunction with marginal strips around the Mata-Au/Clutha River), and other affected parties.
- Any necessary archaeological authorities required need to be sought ahead of investigative works commencing, which would include detailed plans of work and specific assessment of effects of the values of each site.
- It is considered that further work on identification of options for mitigation of potential effects could be undertaken once further detailed surveys have been undertaken.

12 Soils

This chapter of the EIS addresses the potential effects of the project on the life-supporting capacity of soils (including those with particular productive value).

Although a comprehensive analysis of the existing soils has not yet been completed, there are a variety of reports and data inputs which provide general information pertaining to this topic. Those sources, together with information from the relevant statutory instruments (contained in **Chapter 18: Legislative context**), have informed the assessment below. To that end, based on the information available, the chapter describes the soil types and associated Land Use Capability (LUC) classifications within the project area, and the potential impacts that the project may have on those soils.

It also identifies potential options for addressing any adverse effects of the project on soils, should they arise.

12.1 Baseline environmental characteristics

12.1.1 Soils overview

Throughout the relevant statutory and regulatory documents, all soils within the Otago region are recognised and valued for their intrinsic life-supporting capacity, and in the case of specific soil types, for their specific value in enabling and supporting primary production. Those specific soils are variously referred to as 'highly productive soils or land', 'significant soils', or 'high-class soils' in the relevant plans. As set out in **Chapter 18: Legislative context**, these particular categories of soils are subject to a more stringent management approach, reflecting their inherent value. In most instances, the relevant regulatory framework will seek to protect such soils for productive use.

A common index used to categorise soils is the LUC system, a nationally recognised classification system which categorises the ability of an area to sustain one or more productive uses based on physical limitations and site-specific management needs. This assessment takes account of a range of factors including rock type, soil, slope, vegetation, climate, the effects of past land use, and the potential for erosion. As illustrated in Figure 12.1 below, LUC classes 1-4 generally have multiple uses whereas LUC classes 5-6 are best suited to pastoral or forestry uses.

Figure 12.1: Land Use Capability Classes

Increasing limitations to use ↓ / *Decreasing versatility of use* ↓

<table>
<tr><th>LUC Class</th><th>Arable cropping suitability†</th><th>Pastoral grazing suitability</th><th>Production forestry suitability</th><th>General suitability</th></tr>
<tr><td>1</td><td rowspan="4">High
↓
Low</td><td rowspan="7">High
↓
Low</td><td rowspan="7">High
↓
Low</td><td rowspan="4">Multiple use land</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td><td rowspan="4">Unsuitable</td><td rowspan="3">Pastoral or forestry land</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td>Unsuitable</td><td>Unsuitable</td><td>Conservation land</td></tr>
</table>

Source: Lynn et al (2009). *Land Use Capability Survey Handbook. A New Zealand Handbook for the Classification of Land*. 3rd edition. Figure 2, p9.

The LUC classes are described as:[241]

- **Class 1: Arable** | Most versatile multiple-use land, minimal limitations, highly suitable for cropping, viticulture, berry fruit, pastoralism, tree crops and forestry.
- **Class 2: Arable** | Very good multiple-use land, slight limitations, suitable for cropping, viticulture, berry fruit, pastoralism, tree crops and forestry.
- **Class 3: Arable** | Moderate limitations, restricting crop types and intensity of cultivation, suitable for cropping, viticulture, berry fruit, pastoralism, tree crops and forestry.

For most of the relevant regulatory documents, classification within LUC 1, 2 or 3 will indicate that the soils in question are 'highly productive' unless other factors apply. Similarly, the draft National Policy Statement on Highly Productive Land (draft NPS-HPL)[242] specifies that where a specified quantum of land is classified as LUC 1,2, or 3, it will, by default be considered 'highly productive', unless a more detailed assessment demonstrates that it is not by reference to a range of other factors, such as climate.[243]

By way of illustration, under the pRPS the size and geographical cohesiveness of the area for primary production may mean it does not qualify as 'highly productive', notwithstanding that it falls within LUC classes 1–3. Under the partially oRPS, the degree of significance for that area for primary production is also a relevant consideration.

Confirmation of whether an area is actually 'highly productive' under the oRPS and pRPS (or the draft NPS-HPL) therefore requires a detailed, site-specific assessment. This assessment has not yet been completed for the project area and as such, the following information utilising the LUC is indicative only.

---

241 Manaaki Whenua - Landcare Research. (2022). NZ Land Atlas /Land Use Capability Land Use Capability » Maps » Our Environment (scinfo.org.nz).

242 Ministry for the Environment and the Ministry for Primary Industries. (2019). *Valuing highly Productive Land. A Discussion Document on a Proposed National Policy Statement for Highly Productive Land'*. MPI Discussion Paper 2019/05.

243 It is noted that there are other facets to this definition and that there are limitations to the use of the Land Use Capability classification system in determining the 'productivity' of land.

12.1.2 Soil types within the project area

Soils within the Central Otago District are generally described in the Central Otago District Plan (2008) as semi-arid soils (predominantly brown-grey earths) that have been formed primarily by erosion of the schist mountains in the area and the subsequent deposition by fluvial (river) and aeolian (wind borne) means. More specifically:

- Soils within the river valleys generally have a cover of silt loam material that varies in depth. These soils are some of the most fertile in Aotearoa New Zealand as they are naturally high in pH, phosphate, potassium and magnesium but generally deficient in sulphur and boron.
- Yellow grey earth hill country soils range from 550 to 1000mASL in elevation. These have been developed for pastoral farming using oversowing and topdressing with some cultivation.
- High country soils (yellow brown earths) are found above 900m with over 900mm of rainfall; these have low natural fertility.

Within the Lake Onslow area the following soils are present:[244]

- Brown soils (Teviot and Teviot Hill Soil) | Teviot soils typically form under tussock in the uplands of Otago. The topsoil consists of sandy and silt loams with few rock inclusions over silt, sand or occasionally clay loam subsoils.
- Organic kaherekoau soils | these typically form in decomposed remains of wetland plants (peat). Kaherekoau soils consist of dark brown to black peat resting on blue-grey silt.

12.1.3 LUC classifications of soils within the project area

Mapping on the NZ Land Atlas website (Manaaki Whenua - Landcare Research) illustrates that the soils within the project area fall within a range of different LUC classes. [245]

As illustrated by Figure 12.2:

- Most (if not all) of the soils surrounding Lake Onslow inundation area are classified as LUC 6 or 7 and are 'non-arable'.
- The tunnels for all three lower offtake options will encounter some LUC 4 (arable) soils.
- The lower offtake options at s 9(2)(i) will encounter some LUC 3 soils, which are located adjacent to the Mata-Au/Clutha River.

Adopting the draft NPS-HPL approach, those LUC 3 soils may therefore, by default, be considered 'highly productive' unless further technical analysis can demonstrate by reference to other factors that such a classification is not warranted.

The implications of this classification, and the potential effects of the project on soils more broadly are addressed below.

[244] New Zealand Heritage Properties Limited. (2022). *Lake Onslow Hydro Storage Project A Desktop Assessment of Archaeology and Heritage*, page 15.

[245] Manaaki Whenua - Landcare Research. (2022). NZ Land Atlas /Land Use Capability Land Use Capability » Maps » Our Environment (scinfo.org.nz).

s 9(2)(i)

[redacted]

12.2 Impact of project on the baseline characteristics

Those project options that would utilise offtakes at either s 9(2)(i) [redacted] will intersect with areas containing LUC 3 soils adjacent to the Mata-Au/Clutha Rive. Earthworks required to establish those offtake options may result in:

- The loss of some, if not all, of those soils
- The loss of vegetation cover, which could increase susceptibility of the project area to erosion
- Disruption to and loss of topsoil, which increases the risk that it could be discharged into nearby water bodies.

Further assessment will be required to determine the significance of that loss. If that analysis confirms the relevant areas constitute 'highly productive' soils, their loss would be inconsistent with the current 'direction of travel' within the existing regulatory documents, which is to prioritise such soils for primary production and/or protect them from further losses.

If the soils are not found to be 'highly productive', the policy focus within the relevant planning documents is on maintaining the health of soils and minimising soil erosion.

12.3 Options to address impacts

As discussed above, there are limited, if any, options available for avoiding, remedying or mitigating the loss of productive soils. Further investigation into potential offsetting or compensation measures could be undertaken, if it is confirmed that the LUC 3 soils near the s 9(2)(i) [redacted] offtakes are in fact 'highly productive'.

For all other matters relating to soil health, Management Plans are generally used in projects of this nature to address issues such as earthworks staging, site rehabilitation and erosion and sediment control. Specific mitigation measures would be included within those Plans to address adverse effects relating to soil health and stability and would be updated as further information regarding the construction and operation of the project was available.

12.4 Information gaps and risks to decision-making

As set out above, there are currently information gaps relating to the areas of land near the s 9(2)(i) [redacted] offtake areas which are identified to contain LUC 3 soils. At this stage, it is not clear whether those areas would qualify as 'highly productive land' or 'significant soils' under the relevant regulatory documents.

The information gap pertaining to the classification (or otherwise) of the LUC 3 soils is considered a medium to low risk to the decision as to whether to proceed with the proposal. The loss of highly productive soils is inconsistent with the statutory policy direction which seeks to protect such soils for their productive potential now and into the future. That loss, even if realised, is however, likely to be offset by the overall environmental benefit of the project. As such, this information gap is not considered to pose a significant risk to decision-making on whether to proceed with the project.

13 Contamination

This chapter outlines the risks associated with both encountering contaminated land as part of the project development and with the project contributing to the contamination of land during its construction and/or operation.

Although a comprehensive analysis of the potential areas of contamination and potential sources of contamination have not yet been completed, there are a variety of reports and data inputs that provide general information pertaining to these topic areas. Those sources together have informed the assessment below. To that end, based on that information, the chapter describes:

- The location of potentially contaminated land within the study area
- Potential sources of contamination as part of the construction and/or operation of the project.

It also identifies potential options for addressing any adverse effects of the project on those matters, should they arise.

13.1 Baseline environmental characteristics

The Otago Regional Council maintains a register of sites with current or past land uses that are identified on the Hazardous Activities and Industries List (HAIL) as having the potential to contaminate land (HAIL sites).[246] Identification of a property on this register is not confirmation that the property is contaminated, nor is the register a definitive record of all potentially contaminated sites. It does, however, provide an indication of a higher probability that the site is contaminated based on the recorded prior use of the land.

13.1.1 HAIL sites within the project area

Figure 13.1 shows the location of HAIL sites within the broader project area.

As illustrated, the majority of identified HAIL sites are located within or in close proximity to towns and settlements such as Roxburgh and Millers Flat. None of these HAIL sites, however, appear to actually intersect with the key components of the project.

If a HAIL site of interest to the scheme is subsequently identified, further desktop assessments known as preliminary site investigations will need to be undertaken to confirm the existence and extent of any contamination. The outcome of that analysis will determine what, if any, actions are required to remediate those sites, and otherwise avoid, remedy or mitigate potential adverse effects of that contamination.

[246] Otago Regional Council. (2022). Hazardous Activities, Industries and Bores Search, *https://maps.orc.govt.nz/portal/apps/MapSeries/index.html?appid=052ba04547d74dc4bf070e8d97fd6819.*

s 9(2)(i)

13.2 Impact of project on the baseline characteristics

The project could generate adverse contamination effects in two ways. The first is through the disruption of existing contamination that could result in further effects on human health and the surrounding environment. The second way is by causing contamination of land through the discharge of contaminants to ground (discharges to air are discussed in **Chapter 14: Air Quality**).

As set out above, currently there are no recorded HAIL sites that intersect with the key components of the project. If, however, contaminated areas are discovered, then remediation or removal of that contamination will likely be required ahead of:

- The change in use of those sites from their previous use to supporting the establishment of the project
- Any earthworks on those sites to enable the project.

Within the project, the following activities could potentially result in contamination of land:

- The storage or use of chemicals required for the construction or operation of the project
- The storage of batteries, electrical transformers or other heavy electric equipment
- The storage and/or use of explosives
- Vehicle refuelling areas.

13.3 Options to address impacts

In most cases, specific measures and controls relating to remediation or removal of contaminated land would be detailed in a Management Plan.

For activities forming part of the project which could potentially result in contamination of land, again, specific Management Plans would control how those activities occurred on site, including any storage or use requirements for sources of contamination.

13.4 Information gaps and risks to decision-making

As set out above, the existence or extent of any contamination within the project area is not yet known.

While that means that the requirements for, and cost of, any remediation cannot yet be quantified, the project area is (and has been) sparsely populated with reasonably static land use, and as such the risk of extensive contamination being encountered is anticipated to be low. Where it is encountered, there are well-established decommissioning/decontamination methodologies and processes for removal and disposal of contaminated land. As such, this information gap is not considered to add significant risk to decision-making on whether to proceed with the project.

14 Air quality

The project will include activities which result in discharges of contaminants to air with associated air quality effects.

This section provides an overview of the existing ambient air quality within the project area based on the information available and outlines the likely components of the project which could generate adverse effects on air quality.

The scale and extent of those adverse effects have not yet been the subject of technical assessment; however, this section identifies likely discharge sources, and standard industry responses to such issues should they arise.

It is noted that this section does not address greenhouse gas emissions which are dealt with in **Chapter 15: Greenhouse gas** of the EIS.

14.1 Baseline environmental characteristics

The following overview of the existing ambient air quality within the project area is based on information collated from monitoring data collected and published by the Otago Regional Council and Land Air Water Aotearoa. It is also informed by the existing regulatory instruments relating to air quality, which are summarised in **Chapter 18: Legislative context**.

14.1.1 The Otago Region

Monitoring records from sites across the Region show that the existing air quality within Otago generally is 'good' for most of the year, with values within the National Environmental Standards for Air Quality.[247]

Air quality within the Region is influenced by the strong temperature inversion layers which can trap small air borne particulates close to the ground. During winter months, air quality can be poor in certain areas due to increases in home heating emissions from the burning of solid fuel (i.e. wood), and cold, calm weather conditions which can limit the dispersal of inversion layers.

Air quality can also be adversely affected by emissions from transport, burning of waste, agrichemical spray drift and vegetation burning on production land.

The Regional Plan: Air for Otago (2009) (Air Plan) categorises the region into various airsheds and air zones.[248] Controls on air discharges within the Air Plan are primarily set according to the zone and/or airshed in which the subject activity is located. Air Zone 3 applies to the majority of rural land within Central Otago.

The ambient air quality in Air Zones 1 and 2 is expected to exceed the National Environmental Standards for Air Quality (NES-AQ). The Air Zone 3 (includes towns[249]) are not expected to exceed the NES-AQ.[250]

[247] Land Air Water Aotearoa. (2022). Air Quality. *www.lawa.org.nz/explore-data/otago-region/air-quality*

[248] Otago Regional Council. (2009). *Regional Plan*: *Air for Otago*. It is noted that the Plan is currently under review

[249] As outlined above the Air Zone 3 also includes rural areas outside town boundaries

[250] Otago Regional Council. (2021). *State and Trends of Air Quality in the Otago Region 2010- 2019*

The anticipated environmental results for the implementation of the Air Plan (which controls air discharges) are:

- the improvement of ambient air quality
- ensuring that levels of contaminants do not exceed stated levels
- achieving measurable improvements in the levels of PM_{10} [251]measured in Air Zones 1 and 2 (particularly during the months of May to August). There is no equivalent aspiration for Air Zone 3
- reducing disposal of waste by combustion
- increasing the adoption of emissions control technology
- increasing the public awareness of effects of discharges on air quality

14.1.2 The project area

The project area, with the exception of Roxburgh township and its immediate surrounding area, is located within Air Zone 3 of the Air Plan. The Roxburgh township falls within Air Zone 2.

Although there are numerous air quality monitoring sites throughout the Otago Region, none of those are currently located within the project area.

Air quality monitoring was previously undertaken within Roxburgh township (with the latest data provided in 2007) but is now inactive. NIWA has undertaken monitoring in the Alexandra area, focussing on particulate matters, and it is understood that additional air quality monitoring may have been undertaken by other consultancies for the Otago Regional Council in an area that includes Roxburgh; that information, however, is not publicly accessible. Moreover, air quality information from the Land and Water Aotearoa and Otago Regional Council websites do not provide data on transport emissions within the project area.

NIWA has undertaken baseline environmental assessments for the project which include meteorological information that may be of some relevance to the future assessment of air quality within the project area.[252] However, those assessments do not themselves specifically address existing ambient air quality.

Consequently (and in summary), there is no data (including monitoring information) available on the current ambient air quality specifically at Lake Onslow and its immediate surrounds, or for the locations adjacent to the Mata-Au/Clutha River which fall within the project area. There are, however, various features of these areas which provide an indication of what the current air quality environment may be.

---

[251] PM10 is defined in the *Regional Air Plan: Air for Otago* as ''particulate matter that is - (a) Less than 10 microns in aerodynamic diameter; and (b) Measured in accordance with the United States Code of Federal Regulations, Title 40 – Protection of Environment, Volume 2, Part 50, Appendix J – Reference method for the determination of particulate matter as PM10 in the atmosphere'.

[252] As part of the baseline environmental investigations undertaken by NIWA a new meteorological station was erected approximately 6km southwest of Lake Onslow on Mount Teviot, and a second meteorological station was attached to the Lake Onslow buoy in 2021. These weather stations measure shortwave radiation, air temperature, relative humidity, rainfall, barometric pressure, and wind speed and direction. This information is reported in NIWA *Assessment of Lake Onslow Climate, Hydrology and Ecology* (2022), and may be useful in assessing potential effects of the project on air quality if the project proceeds to a more detailed investigative stage. The background report Te Rōpū Matatau *Hydrology and Hydrological Report* (2022) also provides baseline climatic information.

First, as discussed above, inclusion of most of the project area within Air Zone 3 of the Air Plan suggests that air quality is currently unlikely to be a significant cause for concern in these locations.

Second, the following characteristics of the Lake Onslow area in particular suggest that air quality at the Lake and its surrounds is likely to sit within acceptable limits set out in the NES-AQ[253] because:

- It is an open, high-country landscape, with few potential sources of air discharges which could adversely affect air quality. In particular, it is sparsely populated, and generally devoid of dwellings (with the exception of the anglers' huts located on the south-eastern corner of the Lake) and non-farm related buildings. As noted above, burning of solid fuels in domestic heating appliances is a significant contributing source of PM_{10} within the region and as such, it can be expected air quality is better in this part of the region that its more urbanised areas.
- There are minimal transport movements in and around this area, meaning emissions from vehicles are likely to be low.

The low numbers of dwellings, transport movements and other sources of air pollution in most areas adjacent to the Mata-Au/Clutha River provide a similar indication as to the likely air quality in those locations.

Roxburgh's inclusion within Air Zone 2 of the Air Plan is unsurprising given it is a populated township. Otago Regional Council records show that small airborne particulates (PM_{10}) peak in some Central Otago towns in winter during mornings and evenings, with the main source of PM_{10} is from the burning of solid fuels in domestic heating appliances.

Again, there is no data on current air quality levels within Roxburgh and its immediate surrounds. Notwithstanding its inclusion in Air Zone 2, the results of the 2007 monitoring did, however, show that at that time, existing ambient air quality was 'very good'[254].

14.2 Impact of project on the baseline characteristics

The project includes activities which will result in discharges to air at both the construction and commissioning/operation stages. It is possible that those discharges may have some effects on air quality.

14.2.1 Construction stage

The discharge of contaminants to air, and associated effects on air quality, are generally expected to occur from:

- Dust particulates (which will be created during bulk earthworks, including quarrying and spoil disposal, and from the use of existing infrastructure for construction purposes: i.e., the use of unsealed roads and other surfaces within the area)
- Transportation emissions (construction vehicles), depending on fuel type
- Concrete batching plants and other industrial processes established to support the construction of the project
- The operation of diesel generators to support construction activity
- Potential discharge to air from any temporary infrastructure required for construction base depots or worker accommodations (domestic heating)

[253] Resource Management (National Environmental Standards for Air Quality) Regulations 2004 (revised in 2011).

[254] Land Air Water Aotearoa. (2022). Air Quality-Roxburgh. www.lawa.org.nz/explore-data/otago-region/air-quality/roxburgh.

In the absence of appropriate management, these discharges all have the potential to adversely affect human health (respiratory), values of significance to Kāi Tahu,[255] the health and functioning of eco-systems, plants and animals, cultural, heritage and amenity values, and surrounding farming practices (including crop production).

14.2.2 Commissioning/operation stage

Ongoing effects of the operation of the project on air quality are anticipated to be limited to those associated with the ongoing operation of any infrastructure (such as the use of equipment which discharges contaminants into air), and the potential for dust effects from the exposed littoral zones at both the upper and lower reservoirs when water levels in these reservoirs are low.

14.3 Options to address impacts

In most projects of this nature, matters relating to air quality effects during construction would be dealt with in a comprehensive Dust Management and/or Erosion and Sediment Control Plan. This would address matters such as potential sources of discharges to air, the staging of earthworks, dust control measures, site rehabilitation and transport management.

Mitigation measures to address potential dust related effects, including effects on specific properties and farming operations would be included in such a Management Plan and developed in detail when further information on the construction and operation of the project was available.

It is expected that any discharge to air associated with the operation of temporary construction facilities (worker accommodation or equipment) would be able to be adequately avoided, remedied or mitigated through factors such as the specification of heating sources in any housing, and the siting of such infrastructure in relation to habitable buildings. In addition, dust impacts arising from the exposure of the littoral zone at the upper reservoir during periods of drawdown will need to be managed so as to minimise the duration and severity of these impacts where possible.

14.4 Information gaps and risks to decision-making

As set out above, there are two main information gaps relating to air quality issues for the project:

There is currently no available data on current air quality for the general Lake Onslow area or for specific locations within the project area that are adjacent to the Mata-Au/Clutha River.

No technical assessment of the effects of the project on existing ambient air quality has yet been completed.

In terms of understanding the implications of the project for the particular topic area, these gaps are significant. However, they are not considered to add significant risk to decision-making regarding the feasibility of the project for the following reasons:

- From the information that is available, existing air quality within the project area does not appear to be an issue of significant and immediate concern for the region.

[255] Cultural effects of air pollution can include negative impacts on the mauri of air as a taoka, and other taoka such as living things that require clean air. Discharges to air may adversely affect significant places and taoka such as marae, wāhi tapu, mahika kai, water, and indigenous flora. From the Kāi Tahu perspective the taoka must be placed intact to the next generation and be enhanced where it is degraded.

- While there are likely to be potentially significant discharges of dust to air associated with the construction stage of the project in particular, there are well-established methods for managing those discharges which are likely to be relatively effective in this instance.

14.5 Recommended future actions

If the project proceeds, it is recommended that the following further work is undertaken:

- Identification of the baseline ambient air quality characteristics within the project area, which may include:
  - Discussions with NIWA regarding the potential to extend existing meteorological observations to include air quality once the design option(s) have been further refined and further constructability information is available.
  - Discussions with Otago Regional Council on the potential to reinstate the previous air quality monitoring at Roxburgh.
- Completion of a technical assessment on the actual and potential effects of the both the construction and ongoing operation of the project on that existing ambient air quality.

15 Greenhouse gas

This chapter identifies potential sources of greenhouse gas emissions from the project and the expected quantum of those emissions. It assesses the likely impact of those greenhouse gas emissions within the Lake Onslow catchment, taking into account existing land uses that contribute greenhouses gases, and identifies options for reducing such emissions.

This section has been informed by technical assessments undertaken by NIWA and preliminary work by Te Rōpū Matatau.[256]

15.1 Greenhouse gas emissions

Greenhouse gases are atmospheric gases that intercept long-wave radiation from the earth's surface and redirect it back to earth. This causes the 'Greenhouse Effect', the warming of the earth's surface.[257] While there are natural greenhouse gases, man-made greenhouse gases are contributing to an increased rate of the Greenhouse Effect. These typically include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and various chlorine and bromine containing compounds such as sulphur hexafluoride (SF_6) and chlorofluorocarbons (CFCs).[258]

All land uses can either release (emit) or sink (absorb) greenhouse gases. The quantum of such gases can be presented as separate rates for each gas, or combined and presented as a single carbon dioxide equivalent number (CO_2-eq)[259] .

A carbon dioxide equivalent (CO_2-eq)[260] is a metric measure used to compare the emissions from various greenhouse gases on the basis of their '100-year global warming potential'. CO_2-eq reflects the equivalent amount of CO_2 that would need to be released into the atmosphere to have the same effect on the earth's temperature as the subject greenhouse gas over a 100-year timeframe.

15.2 Baseline greenhouse gas emissions

Identifying the existing extent/rate of greenhouse gas emissions provides both an understanding of the existing environment and one of the key inputs for measuring net greenhouse gas emissions (measured as CO_2-eq) for any given project.

Net emissions are the 'post impoundment' emissions (i.e. emissions from the new reservoir and wider catchment) minus the 'pre-impoundment' emissions from the catchment (i.e. the catchment as it exists before the new reservoir is included).

Using the following methodology, NIWA has identified the baseline CO_2-eq for the Lake Onslow catchment[261] by:

---

256 NIWA. (2022). *Assessment of Lake Onslow climate, hydrology and ecology*; NIWA. (2022). *Addendum to Lake Onslow baseline reports*

257 NIWA. (2022). *What are greenhouse gases*? https://niwa.co.nz/atmosphere/faq/what-are-greenhouse-gases

258 NIWA. (2022). *What are greenhouse gases*? https://niwa.co.nz/atmosphere/faq/what-are-greenhouse-gases

259 the relative global warming potential of each gas normalised to CO_2

260 the relative global warming potential of each gas normalised to CO_2

261 Refer to Figure 1.1 and Table 9.3 in NIWA. (2022). *Assessment of Lake Onslow climate, hydrology and ecology*

Identifying the existing land use components within the Lake Onslow catchment, including the size (area) of those components (i.e. the pre-impoundment catchment)

Estimating the total emissions from those components based on their area and the application of emissions factors/estimates and other data for those components drawn from various sources including the National Inventory Report (i.e. the pre-impoundment emissions rate).

This methodology closely follows the Intergovernmental Panel on Climate Change Method Guidelines for Greenhouse Gas Inventory (IPCC, 2006), and is compatible with the methods used for the New Zealand Greenhouse Gas Inventory (National Inventory Report 2021).

In undertaking its assessment, NIWA noted that the pre-impoundment catchment included tall tussock grasslands, improved pasture, livestock, wetland, and Lake Onslow itself. Acknowledging that there are numerous characteristics which influence the variability in greenhouse gas emissions from lakes and reservoirs, including climate, geology, vegetation, land use, water body size, depth and water quality, these characteristics have been accounted for as far as possible in the calculation of the emissions rates for the Lake.

The pre-impoundment catchment also includes a forest block located within the Onslow catchment, which was assessed as an emissions sink (meaning it absorbs rather emits greenhouse gases).

The results of emissions analysis for the existing catchment are set out in the table below.

Table 15.1: Area-based emissions and total emission from the Lake Onslow catchment (as CO_2-eq)

Land use component	Area-based emissions (t CO_2–eq/km²/y)	Total area (km²)	Total catchment emissions (t CO_2–eq/y)	Area below 760 mRL (km²)	Catchment emissions below 760m (t CO_2-eq/y)	Method
Tall tussock grassland (excluding ag. Emission)	0	114	0	42.4	0	Using NIR method of net neutral emission for 'Grassland remaining Grassland' (NIR 2021)
Improved pasture (excluding ag. Emission)	0	11.2	0	11.2	0	
Pastoral ruminant animal CH_4	27	155	4210 (3160 with standoff) **	53.7	2560 (1920 with standoff) **	Estimates based on NIWA high resolution agricultural livestock data
Pastoral N_2O##	3.6	155	560 (420 with standoff)	53.7	320 (240 with standoff)	
Wetland	0	5.9	0	3.6	0	Estimated from Section 6.7.2 of NIR 2021
Current Lake Onslow	14.3	12.3	250	12.3	250	Estimate from NZ available lake data in Table 2 of NIWA Report March 2022
Forest block	-330	1.3	-440	0.65	-220	Upland forest: G-res Tool Table 10 p.49

Land use component	Area-based emissions (t CO_2–eq/km²/y)	Total area (km²)	Total catchment emissions (t CO_2–eq/y)	Area below 760 mRL (km²)	Catchment emissions below 760m (t CO_2-eq/y)	Method
Total includes high-resolution catchment based ruminant CH_4		**175**	**4580 (3392 with standoff)**	**69.4**	**2910 (with standoff)**	

Source: NIWA. (2022). *Assessment of Lake Onslow climate, hydrology and ecology*.

** The ruminant emissions in the table have been reduced by 25% to account for removal of stock from the catchment in winter, based on farming practice in the region. Note that emissions follow a seasonal pattern, for the Otago region, they are characteristically ca 40% less in winter compared to mid-summer (Geddes pers. comm).

In summary, NIWA's preliminary analysis estimated that:

- The total pre-impoundment emissions rate for the whole Lake Onslow catchment is currently 3,392 tonnes of CO_2-eq per year
- The total pre-impoundment emissions rate for the [lake inundation area] (760mRL with an area of 69.4km²) is 2,910 tonnes of CO_2-eq per year.

15.3 Impact of the project on baseline greenhouse gas emissions

The potential sources of greenhouse gas emissions from the project fall into two broad categories. The first is the expansion of Lake Onslow in order to create the upper reservoir. All lakes and reservoirs emit greenhouse gas emissions (as illustrated in Table 15.1 above), and this will apply to both the existing and enlarged Lake and the lower reservoir (which has not yet been assessed). The expansion of the Lake will impact the quantum of greenhouse gases that it (and therefore the wider catchment) currently emits. The second category captures all other potential sources, identified in Table 15.2 below.

The potential quantum of emissions which may be attributable to each category has been the subject of preliminary assessments by NIWA (for the inundated Lake) and the project team (for the other components). The results of those assessments are summarised below.

15.3.1 Emissions from the future/inundated Lake Onslow (760mRL)

Taking the baseline pre-impoundment emissions rate, NIWA has undertaken a preliminary calculation of the potential greenhouse gas emissions (expressed as CO_2-eq) which could arise as a result of the inundation/expansion of Lake Onslow (the 'post-impoundment' rate). That rate is the sum of the following three forms of emissions which typically emanate from lakes and reservoirs:

- Diffusive emissions: which occur when the gas concentration in the lake water is higher than in the atmosphere above.
- Bubbling emissions: which occur in some cases when CO_2 or CH_4 concentrations reach supersaturation levels that are high enough to initiate the creation of gas bubbles within sediments. This is often the result of a sudden change in water level or pressure resulting in the release of bubbles to the atmosphere.

- Degassing emissions: which occur where reservoir outflow drawdown includes anoxic hypolimnetic water and high dissolved CH4 concentrations. Greenhouse gases are released to the atmosphere by the pressure drop after the water leaves the outlet.[262]

To calculate the post impoundment rate, NIWA utilised a specific reservoir emissions software tool (G-res Tool) which accounted for the following inputs:

- The specifications for the inundated Lake Onslow (at 760mRL), including the area and depth of the future lake, its impoundment year, and average water residence times
- Climate data for the area, including annual windspeeds and temperatures
- Water quality from the Mata-au/Clutha (oligotropic (low algal) conditions)
- Preliminary information on likely stratification of the future Lake.

With those inputs, the G-res Tool estimated a post-impoundment emissions rate for the inundated Lake at 4035 tonnes of CO_2-eq per year. NIWA then modified that prediction to account for a difference in the 'global warming potential over 100-years' rate, which generated a result of 780 tonnes of CO_2-eq per year.

Based on this estimate the net greenhouse gas emissions predicted as a result of the inundation of Lake Onslow (at 760mRL) are 1590 tonnes of CO_2-eq per year, which represents the post-impoundment rate (3780) minus the pre-impoundment rate (2190). That rate assumes that the operational activities (e.g. pumping) use renewable energy supplies (i.e. do not contribute greenhouse gas emissions).

According to NIWA's analysis (which draws on data from the G-res Tool), that emissions rate is at the lowest end of emissions from hydropower reservoirs worldwide and are expected to be only slightly higher than emissions from current land use in the inundation area. It is expected that greenhouse gas emissions would be highest immediately after the inundation phase due to the decomposition of the submerged vegetation. This period would likely last between five and 20 years.

15.3.2 Emissions from other sources of the project

The likely sources that could contribute to the project's overall greenhouse gas emissions have been identified in the **Feasibility Study Report, Sustainability chapter** and are summarised in the table below. These include the use of materials with embodied carbon, the transport of materials and the use of vehicles/machinery and energy/water throughout the project lifecycle.

Activities associated with raw material supply and extraction, manufacturing and fabrication, construction and installation, and reservoir emissions are estimated to be the highest likely contributors to the project's greenhouse gas emissions (or overall carbon footprint).

Table 15.2: Likely carbon footprint sources for the project[263]

	Construction	Operation
Carbon component	• Raw material supply/ extraction • Transport to manufacturer • Manufacturing and fabrication • Transport to project site • Construction/installation	• Use • Maintenance • Repair • Refurbishment • Replacement • Energy use

[262] NIWA. (2022). *Assessment of Lake Onslow climate, hydrology and ecology*; NIWA. (2022). *Addendum to Lake Onslow baseline reports*

[263] If the project was to be decommissioned, that phase of the project would also have a carbon footprint.

	Construction	Operation
		• Water use • Other processes • Users of infrastructure
Key infrastructure & carbon source	• Material • Quarry extraction • Vehicle emissions • Manufacture process materials (concrete, steel) and electricity	• Decomposition of organic material within reservoirs • Concrete carbonation • Vehicle and machinery emissions • Energy/electricity used to maintain the asset • Water and wastewater treatment • Waste

Source: Te Rōpū Matatau

15.4 Options to address impacts

Currently, there is no way to completely avoid the emission of greenhouse gases from the future Lake Onslow. There are, however, a number of mitigation options which may reduce emissions form the Lake and from the wider catchment. Those are set out in full in the NIWA report, and include:

- Minimising hypolimnetic de-oxygenation (due to the decomposition of flooded vegetation) and associated greenhouse gas generation by careful staging of the new inflows.
- Managing nutrient-rich runoff to the new lake to reduce the potential for methane release in the lake, by:
  - s 9(2)(i)
  -

Other opportunities to reduce the project's greenhouse gas emissions during construction, operation and decommissioning include:

- More efficient extraction techniques
- Sourcing materials responsibly
- Replacing raw materials with recycled or reused material
- Manufacturing and fabrication efficiencies
- Use of an electric or low emission vehicle fleet
- Driver training for efficient fuel use
- Using renewable sources of energy and electricity
- Optimising the design to use less materials.

15.5 Information gaps and risks to decision-making

NIWA has identified several factors that have contributed to some uncertainty in the prediction of both the pre- and post-impoundment emissions rates for the Lake. In response, it has identified several actions that could reduce that uncertainty, which are summarised below.

It is not considered that these information gaps add significant risk to decision-making on whether to proceed with the project. The (albeit preliminary) analysis undertaken by NIWA indicates that the project will likely only result in a reasonably minor increase in greenhouse gas emissions from the Lake Onslow catchment. Overall, the predicted emissions rate for the upper reservoir is also low compared with international standards. Due to the smaller scale of the lower reservoir, this is also predicted to be the case. While more detailed measurements and analysis will assist in clarifying that rate, it is not expected to result in a dramatic shift.

15.6 Recommended future actions

If the project proceeds, it is recommended that all of the following actions are taken to improve the estimation of greenhouse gas estimates from Lake Onslow:

- Direct measurements of emissions via the use of analytical techniques that have been employed on other reservoirs and lakes in Aotearoa New Zealand including:
  - Calculating emission fluxes using infra-red laser techniques across a lake surface, by directly measuring greenhouse gases across the air-water interface or by measuring dissolved CO_2 concentrations in the water from alkalinity, pH and temperature.
  - A survey using chamber measurements on soils and floating chambers on the lake and vegetated wetland areas which would provide more accurate measures of current greenhouse gas emission rates over the four seasons.
- Assessing the total carbon in the catchment vegetation to be flooded
- Estimating the decomposition rates and oxygen uptake rates for newly flooded soil and vegetation
- Different modelling methods and remote sensing methods – including modelling the likely trophic upsurge after soils and terrestrial vegetation are submerged
- The drawdown rates, filling rates and operating ranges are likely to affect lake water dissolved oxygen concentration. An assessment of the feasibility of using the multi-level intakes/outlets and other means of mixing and aeration to manage oxygen levels and associated risk of increasing greenhouse gas emissions from lake sediments is recommended.

If the project progresses to the next phase, more details about the construction, operation and maintenance requirements would be developed. With this information, a more accurate estimation of greenhouse gas emissions could also be calculated for the project.

16 Natural hazards

As part of its engineering feasibility study, Te Rōpū Matatau has investigated natural hazard risks within the project area, and the ways in which those risks could be appropriately managed through the layout, design and operation of the project.[264]

As set out in **Chapter 18: Legislative context**, managing the risks of natural hazards is a particular matter of focus within the Resource Management Act 1991, and its subsidiary documents. Where an activity is proposed to be located in an area under significant threat from natural hazards or where it might significantly exacerbate existing natural hazard risks, the necessary statutory approvals may be declined, or may only be granted subject to conditions around management of that risk which can add significant cost.

In that context, this chapter briefly summarizes the potential natural hazard risks within the project area, and how those risks might impact, or be exacerbated by, the project. It draws on analysis undertaken by Te Rōpū Matatau (which is set out in more detail in **the Feasibility Study, Site setting chapter**), and information contained in the Natural Hazards Portal managed by Otago Regional Council.

16.1 Baseline environmental values

The Otago Regional Council maps natural hazards in the Otago region and identifies them on the Otago Natural Hazards Portal Map (Portal map). Within the project area, the Portal map identifies specific locations which are potentially subject to landslides and erosion, flooding and seismic risk, each of which are shown on Figure 4.1 and 4.2 and are discussed in further detail below.

16.1.1 Landslides and erosion

The topography of the project area is generally characterized by gently sloping hillsides particularly around Lake Onslow and down toward the three alternative offtake locations on the Mata-Au/Clutha River. Consistent with this, the portal maps show only confined locations within the project area where landslide activity has occurred, namely:

- Between Lake Onslow and the Mata-Au/Clutha River within the Teviot Valley, where several minor landslide features are shown on Figure 16.1
- Within the gorges of Lake Roxburgh and Beaumont Gorge, where there is evidence of several dormant landslides as shown on Figure 16.1

Additional information regarding the existence and extent of landslide risk within the project area is contained in **Feasibility Study, Site setting chapter.**

The Portal map shows active floodwater-dominated alluvial fans to the northeast and southeast of Lake Onslow and just south of the Roxburgh Dam, while active composite alluvial fans are shown to the west of the Mata-Au/Clutha River. Active alluvial fans such as these can compromise land stability. However, the gentle slopping nature of the area around Lake Onslow, including the alluvium areas, means that the overall risks of slope failure and erosion are low.

[264] Te Rōpū Matatau. (2022). *Feasibility Report* (NZBLO-TRM-01B-010-RPT-MDP-000379-A), Site setting chapter; Te Rōpū Matatau. (2021). *Geological, Geotechnical and Hydrogeological Data Report (*NZBLO-TRM-01A-10-RPT-GEO-000051-A), Section 7

Overall, the risk of erosion is considered low across the project area due to the gentle slopes and good vegetation cover, even across the highest parts of the Lake Onslow highlands.[265]

16.1.2 Flooding

Within the project area, only the Mata-Au/Clutha River and its margins are identified in the portal map as being a flood hazard area (refer to Figure 16.1).

[265] Te Rōpū Matatau. (2021). *Geological, Geotechnical and Hydrogeological Data Report (*NZBLO-TRM-01A-10-RPT-GEO-000051-A), Section 7

s 9(2)(i)

16.1.3 Seismic

The rates of recorded seismicity in the vicinity of the project area are very low. The GeoNet catalogue shows no earthquakes of magnitude greater than four having occurred since 1964 in the vicinity of Lake Onslow.

The Portal map and Community Fault Model show a number of active and potentially active faults located within the project area.[266]

Within the Lake Onslow area, the Long Valley Fault traverses along the eastern edge of the Lake (shown on Figure 16.2). Analysis conducted to date suggests it has a recurrence interval (average time between earthquake events) of 20,000 years, with the most recent ground-rupturing event estimated to have occurred some 7-14,000 years ago.[267]

The Lake Onslow Fault (shown on Figure 16.2), is located to the immediate west of the Lake body. No geological field investigations of this fault have yet been conducted, but features of the fault identified through a desktop review suggest it is ‘potentially active’ with an assumed recurrence interval of one million years or more.

A range of other ‘potentially active’ faults would intersect with, or are in close proximity to, the offtake options and the identified pipeline locations. These include the s 9(2)(i) [redacted] the latter of which runs through the middle of the s 9(2)(i) [redacted] offtake option location.

In the event of an earthquake, ground shaking will vary depending on ground conditions, with soft sediments typically experiencing higher shaking levels compared to rocks. Based on the information comprised in the portal maps (refer to Figure 16.2), the majority of the project area is rock with very soft soils present to the south of Lake Onslow, and deep/soft soil near the s 9(2)(i) [redacted] offtake options.

---

266 Seebeck, et al. (2022). *New Zealand Community Fault Model* – version 1.0. Lower Hutt (NZ): GNS Science. 96 p. (GNS Science report; 2021/57).

267 Stirling, M. (2022). *Onslow Project Area: Deterministic Earthquake Hazard*, University of Otago, citing Meyer, AFT. (2021). *A paleoseismic investigation of the Long Valley Fault, Central Otago*. A thesis submitted for the degree of Bachelor of Science with Honours at the University of Otago, New Zealand.

s 9(2)(i)

16.2 Impact of the project on baseline values

In light of the baseline geological conditions, Te Rōpū Matatau has undertaken preliminary analysis of the landslide and erosion risk which might be encountered and/or exacerbated by the project.[268] A preliminary seismic hazard assessment has also been completed. Beyond informing the design parameters of the project components, a detailed assessment of the potential impacts of the project on flooding has not yet been undertaken.

The analysis which has been completed suggests that:

- The proposed increased water level of Lake Onslow would not create any significant landslide hazards. While the reservoir rim may fluctuate over time, which can cause elevated groundwater levels and instability, due to the gentle slopes surrounding the proposed upper reservoir, landslides are not expected to be a hazard.[269]
- The only alluvial fan which would intersect with the project is adjacent to Lake Onslow and would be inundated during establishment of the upper reservoir. The gentle slopes in this area also mean that risk of slope failure is low. Further, the volume of a failure within this fan would be small in the context of the wider inundation area, meaning any landslide induced wave within the upper reservoir would not be hazardous.
- The proposed waterways/tunnels are proposed to be located at a depth below ground that would mean any surface erosion or landslide risk would be unaffected.
- Where there is evidence of potential landslides near the proposed offtake structures, such structures will be cut into the bedrock to mitigate any hazard associated with these features.
- The predicted performance of the proposed dam options would be acceptable under earthquake loading.

16.3 Options to address impacts

Natural hazard risks to, and associated with, the project will predominantly be managed through the design of the various features, and the construction and operational methodology used to deliver it (and secured by conditions on resource and building consents).

16.4 Information gaps and risks to decision-making

At this stage, the Mata-Au/Clutha River is the only identified flood hazard within the project area. Given the proximity of the offtake options and lower reservoirs to the Mata-Au/Clutha River, it will be important to ensure that flood risk is also accounted for in the design and management of those features in order to avoid exacerbating that risk for surrounding areas.

It is not considered that the absence of this information at this juncture presents any risk to making a decision to progress with the project.

---

268 Te Rōpū Matatau. (2021). *Geological, Geotechnical and Hydrogeological Data Report (*NZBLO-TRM-01A-10-RPT-GEO-000051-A), Section 7

269 Te Rōpū Matatau. (2021). *Geological, Geotechnical and Hydrogeological Data Report (*NZBLO-TRM-01A-10-RPT-GEO-000051-A), Section 7

17 Conservation land

This chapter addresses the potential effect of the project on land within the project area which is held for conservation purposes under the provisions of the Conservation Act 1987.

This chapter should be read in conjunction with **Chapter 18: Legislative context** and has been informed by a range of technical assessments contained in Volume Two of the EIS.

17.1 Baseline environmental characteristics

As set out in **Chapter 18: Legislative context**, the Conservation Act 1987 was developed to promote the conservation of New Zealand's natural and historic resources, including through the establishment of the DOC, and empowering it to manage conservation areas.

There are a range of attributes which might contribute to the overall conservation value of an area. These include recreation uses, the presence of indigenous eco-systems, species and their habitats, heritage and/or cultural attributes, and/or the landform, landscapes or geological features of the area.[270]

As illustrated in Figure 17.1, there are two conservation areas within the project area comprising:

- The Manorburn Conservation Area (MCA)
- A series of marginal strips along the edges of various waterbodies, including Lake Onslow, the Mata-Au and Teviot.

[270] Department of Conservation. (2019). *Conservation General Policy*.

s 9(2)(i)

17.1.1 Manorburn Conservation Area[271]

The MCA comprises approximately 2880ha located to the northwest of Lake Onslow. It sits approximately 700-900m above sea level and was set aside as conservation land as part of the Cairnhill/Knobbies tenure review under the Crown Pastoral Lease Act 1998 in the early 2000s.

The MCA is classified as 'stewardship' land under the provisions of the Conservation Act 1987. Stewardship areas are conservation areas which have not yet been classified with any 'special protection', and are not marginal strips or watercourses. They attract the lowest form of protection under the Act.

Notwithstanding, the MCA has a range of attributes which establish its conservation value.

Although no Conservation Management Plan exists for the MCA, it falls within the Backcountry Visitor Management Zone in the Otago Conservation Management Strategy and is predominantly managed for backcountry recreation (hunting, walking).[272] The area also forms part of the Upper Manorburn/Lake Onslow Landscape Management Area in the Central Otago District Council District Plan, which is treated similarly to an Outstanding Natural Landscape.

Red tussock *Schoenus pauciflorus* is identified as the predominant ecosystem and habitat type included within the Manorburn ecosystem unit[273], with preliminary survey work[274] identifying two different types of wetlands located within the MCA: dense red tussock grassland in gully floors, and sphagnum bog/sedge wetland complexes. *Ranunculus ternatifolius* (Threatened–Nationally Vulnerable) and *Carex tenuiculmis* (At Risk-Declining) has been identified in the wetlands, with *Ranunculus ternatifolius* being present occasionally, and *Carex tenuiculmis* recorded only rarely[275].

Teviot flathead galaxias have been recorded within or in close proximity to the MCA and while no Threatened or At Risk bird, plant and insect species have been identified within the MCA itself, species categorised as such have been mapped in close proximity.

Preliminary ecological work also shows the presence of McCann's skink (Not Threatened), southern grass skink (At Risk–Declining), and korero gecko (At Risk–Declining). [276] s 9(2)(i) [redacted]

The area is identified as likely to hold significant concentrations of archaeological features including potential water races, sluice faces, reservoirs, depressions and gold workings, and features of considerable significance to mana whenua.

[271] Information on the Manorburn Conservation Area has been sourced from Department of Conservation. (2022). *NZ Battery Project – Lake Onslow Option. Assessment of Conservation Values at Lake Onslow*.

[272] Department of Conservation. (2022). *NZ Battery Project – Lake Onslow Option. Assessment of Conservation Values at Lake Onslow*, Section 4.1.2.

[273] Department of Conservation. (2016). *Otago Conservation Management Strategy*, Appendix 4.

[274] Johnson, P. (1996). *Manorburn Conservation Area: Vegetation Assessment*. Conservation Advisory Science Notes 135, cited in Wildlands Consultants Limited. (2022). *Desktop Assessment of Vegetation and Botanical Values in the Vicinity of the Proposed Lake Onslow Pumped Hydro Storage Project, Otago*.

[275] Johnson, P. (1996). *Manorburn Conservation Area: Vegetation Assessment*. Conservation Advisory Science Notes 135, cited in Wildlands Consultants Limited. (2022). *Desktop Assessment of Vegetation and Botanical Values in the Vicinity of the Proposed Lake Onslow Pumped Hydro Storage Project, Otago*.

[276] Wildlands Consultants Limited. (2022). *Lizard Species Present (or Potentially Present) in the Vicinity of the Lake Onslow Pumped Hydro Project*. Note – this report focused on the Lake Onslow Basin area only.

17.1.2 Marginal Strips

Marginal strips are strips of land 20m wide which extend along the landward margin of any foreshore, bed of any lake, or river of any stream that has an average width of 3m or more. They are deemed to be reserved to the Crown from the sale or disposition of any Crown land.

With the project area, these strips are held by the Crown under the provisions of the Conservation Act 1987[277] for the purposes of:

- Conservation, in particular the maintenance of adjacent watercourses or bodies of water; and the maintenance of water quality; and the maintenance of aquatic life and the control of harmful species of aquatic life, and the protection of the marginal strips and their natural values
- To enable public access to any adjacent watercourses or bodies of water
- For public recreational use of the marginal strips and adjacent watercourses or bodies of water.

A number of the marginal strips are subject to concessions issued by the DOC to undertake recreational, angling and hunting activities as set out in Table 17.1 below. In addition, many of the marginal strips hold ecological, cultural and heritage values also as identified below.

Table 17.1 Marginal strips

Marginal strips (in general)	Specific marginal strips
Recreation values[278]	
An assessment of the number of DOC concessions by locations at June 2021 identifies various uses of marginal strips within the study area. These concessions were for purposes ranging from guiding (angling), permits to collect, capture, handle release or kill animals to vehicle use. Wild animal control is identified as the dominant activity for which concessions were issued.	Mata–Au/Clutha River: 1. DOC concessions for guided walking issued for conservation land adjacent to the lower river.[279] 2. Reference is made to the use of land adjacent to the river to gain access to the river; for walking, biking, camping, cycling[280], swimming and angling. An angling beach is located within the vicinity of both the proposed s 9(2)(i) intake options (in close proximity to or within a marginal strip). Lake Onslow: 1. The marginal strip on the northern side of the lake and along the Te Awa Makarara/Teviot River is classified as a 'rural' recreation setting. 2. Marginal strips on the southern and central part of Lake Onslow are identified as back country recreation settings. 3. One, possibly three angler huts are located on marginal strip[281] 4. No formed tracks are located on any of these marginal strips[282].

277 Conservation Act 1987, Section 24(C).
278 Rob Greenaway & Associates. (2022). *Aotearoa New Zealand Battery Project. Recreation Values Assessment*
279 Rob Greenaway & Associates. (2022). *Aotearoa New Zealand Battery Project. Recreation Values Assessment*, page 25.
280 This includes the Clutha Gold Cycling and Walking Trail which is located within the marginal strip located adjacent to / within the proposed s 9(2)(i) offtake options.
281 Rob Greenaway & Associates. (2022). *Aotearoa New Zealand Battery Project. Recreation Values Assessment*, p11.
282 Rob Greenaway & Associates. (2022). *Aotearoa New Zealand Battery Project. Recreation Values Assessment*, Section 3.1

Marginal strips (in general)	Specific marginal strips
Heritage values[283]	
Recorded archaeological and heritage sites are located within marginal strips, although it is unclear as to the specific location of these within the marginal strip due to the level of information available. It is noted that the presence of these sites and documented research indicates that other undocumented archaeological sites are likely to be present. Heritage reports also refer to the potential for archaeology relating to early periods of Māori occupation to be present.	Mata-Au/Clutha River: 1. s 9(2)(i) offtake option: there are four recorded archaeological sites within this area. Those closest to the river include sites G43/226-228: mining-gold) 2. s 9(2)(i) intake option: there are four recorded archaeological sites within this area. These include old gold mining sites. Lake Onslow and surrounds (including the Te Awa Makarara/Teviot River and other waterbodies identified as containing marginal strips): 1. A number of recorded archaeological and heritage sites are located along the shoreline of Lake Onslow and adjacent waterbodies. These include G43/9 (a midden/oven site on the northwest margin of Lake Onslow), G43/40 (a schist chimney from a hut associated with Teviot Station) and G43/39 (a possible moa butchery site). 2. Heritage values associated with the Te Awa Makarara/Teviot River adjacent to the MCA will also apply here.
Cultural values	
No specific assessment has been undertaken of the cultural values of the marginal strips. However, the Cultural Values Statement provides some indication of what these are likely to be within the project area.	Lake Onslow and its surrounds: 1. As recognised in the Otago Regional Plan: Water and in the Cultural Values Statement, this area is treasured by mana whenua for its mahika kai and wāhi taoka values. 2. The Statement highlights that, consistent with the aspirations of the NPS-F, restoration of the mahika kai and taoka values of this waterbody is a significant priority for mana whenua. Access to that waterbody is presumed to be an important part of realising this aspiration, and that is currently secured through marginal strips. 3. The Cultural Values Statement also recognises that exotic grass species are growing around the Lake margins, which have resulted in a drop in the instances of native tussocks and grasses – which are indigenous species of important to mana whenua.
Ecological values	
No specific assessment has been undertaken of the ecological values of marginal strips.	Mata-Au/Clutha River 1. A desktop ecological assessment of the three intake options was undertaken by Wildlands Consultants Limited[284]. This identified general ecological values associated with each of these areas, however these are not specific to land title area. Both the s 9(2)(i) offtake and reservoirs include rock outcrops (which could provide potential habitat for Threatened and At Risk plant and lizard species). Lake Onslow and surrounding waterbodies: 1. Extensive ecological assessments have been undertaken by various authors. By way of summary, the map of

283 New Zealand Heritage Properties Limited. (2022). *Lake Onslow Hydro Storage Project;* New Zealand Heritage Properties Limited. (2022). *Lake Onslow Battery Intake Options*.

284 Wildlands Consultants Limited. (2022). *Desktop Assessment of Vegetation and Botanical Values in the Vicinity of the Proposed Lake Onslow Pumped Hydro Storage Project, Otago*.

Marginal strips (in general)	Specific marginal strips
	Threatened and At Risk Bird, Plant and Insect species[285] found at Lake Onslow shows recording of a number of these threatened species during field surveys along the margins of Lake Onslow and waterbodies within this area. Similarly, these marginal strips may be adjacent to areas where galaxiid species and/or koura have been located[286].

Source: Te Rōpū Matatau

17.2 Impact of project on the baseline characteristics

17.2.1 Manorburn Conservation Area

The project will result in the inundation of approximately either 6ha or 46ha of the south-eastern portion of the Manorburn Conservation Area as a result of raising the level of Lake Onslow to a full supply level of 3TWh (745mRL) or 5TWh (765mRL).

As stewardship land, any disposal (in this case by inundation) must be undertaken in accordance with the Conservation General Policy. This means that the land cannot be disposed of unless it has no, or very low, conservation values. In addition, policy 6(d) of the Conservation General Policy provides that land disposal should not be undertaken where the land in question (among other considerations):

- Has international, national or regional significance
- Is important for the survival of any threatened indigenous species
- Represents a habitat or ecosystem that is under-represented in public conservation lands or has the potential to be restored to improve the representation of habitats or ecosystems that are under-represented in public conservation lands.

s 9(2)(g)(i) [redacted]

17.2.2 Marginal Strips

Where the boundary of a lake or river alters as would be the case under the project, new marginal strips around the revised boundaries will likely be required in accordance with the provisions of the Conservation Act 1987 and/or as a pre-requisite to the setting apart of those existing marginal strips for the project under the Public Works Act 1981.[287] The relevant mechanisms within those two Acts are described in more detail in the Consenting Strategy (Te Rōpū Matatau, NZBLO-TRM-01A-010-RPT-CON-000430-C, 2022).

Under the current provisions of the Conservation Act 1987, the location of those new marginal strips would effectively shift as the shape of the lake alters (for example, through water level fluctuations).[288]

[285] Department of Conservation. (2022). *NZ Battery Project – Lake Onslow Option. Assessment of Conservation Values at Lake Onslow*, Figure 3.9 (Threatened and At Risk Bird, Plant and Insect Species found in at Lake Onslow)

[286] Department of Conservation. (2022). *NZ Battery Project – Lake Onslow Option. Assessment of Conservation Values at Lake Onslow*, Figure 6.5, Galaxias species distribution – Teviot Flathead and Yellow Dusky.

[287] For example, Conservation Act 1987, section 24E; Public Works Act 1981, sections 51(2)(d), 52(3).

[288] Conservation Act 1987, section 24G.

The new boundaries of these waterbodies will have implications for the values and uses of the existing marginal strips (s 9(2)(i) [redacted]). However, it is anticipated that the development of new marginal strips, should, over time, offset those impacts.

17.3 Options to address impacts

Options to avoid, remedy, mitigate, offset or compensate the impacts of the project on conservation land are largely dictated by the provisions of legislation such as the Conservation Act 1987, the Conservation General Policy, and the Otago Conservation Management Strategy 2016. s 9(2)(g)(i) [redacted] It is noted that alternative public access to recreational opportunities in the area will be a matter of important consideration in determining the scale and extent of any conservation land disposal or acquisition.

17.4 Information gaps and risks to decision-making

There are significant gaps in the level of information available on public conservation land within the project area. s 9(2)(g)(i) [redacted] It is not therefore considered that the gaps in current knowledge affect the decision as to whether to proceed.

18 Legislative context

The preceding chapters have identified a range of environmental impacts arising from the development and operation of the project which must be considered within the context of Aotearoa New Zealand's environmental laws.

Within that context there are a range of environmental statutes and regulations which currently apply to, and govern the use of, the project area. As set out in the Consenting Strategy (Te Rōpū Matatau, NZBLO-TRM-01A-010-RPT-CON-000430-C, 2022), in the absence of alternative/bespoke legislation authorising the project, the project would fall to be assessed against all of the outcomes and directions expressed within this body of documents which includes:

- The Resource Management Act 1991 (RMA), and its subsidiary planning documents including:
  - the National Policy Statement on Renewable Electricity Generation 2011
  - the National Policy Statement on Freshwater Management 2020
  - the National Environmental Standards for Freshwater 2020
  - the partially operative Otago Regional Policy Statement 2019
  - the proposed Otago Regional Policy Statement 2021
  - the Regional Plan: Water for Otago
  - the Central Otago District Plan
- The Kāi Tahu ki Otago – Natural Resource Management Plan 2005
- The Conservation Act 1987, and its subsidiary policies and management instruments including:
  - the Conservation General Policy
  - the Otago Conservation Management Strategy
- The Biosecurity Act 1993, and the following related documents
  - the Otago Regional Council Biosecurity Strategy, and Pest Management Plan
  - the Otago Biosecurity Operational Management Plan
- The Wildlife Act 1953 and the Native Plants Protection Act 1934
- The Heritage New Zealand Pouhere Taonga Act 2014.
- The Crown Minerals Act 1991.

Reflecting public involvement in law and plan-making processes, the outcomes and directions set out within these documents establish the significance of various aspects of, or values within, the existing environment and set out the way in which those aspects/values should be protected and/or managed. In many instances, those same planning documents will set out what activities are, or are not, considered to be compatible with those values.

As such, even if alternative or bespoke legislation is promulgated with respect to the project, the current legislative and planning framework therefore provides highly relevant information on the matters of importance within this environment; the values worthy of protection and management; and the types of activities that might, or might not, warrant departures or concessions from those protections (be that by way of consents or the promulgation of alternative legislation).

As acknowledged in the Consenting Strategy, the legislative and planning framework is not, however, static. There are a range of legislative and planning documents which are in the process of being developed and/or amended which may (or in some cases will most certainly) also have some bearing on the project. These include:

- The proposed reform of the RMA and the introduction of the Natural and Built Environments Act (due to be introduced 2022) and the Spatial Planning and Climate Adaptation Acts (due to be introduced 2023).
- The proposed National Policy Statement on Indigenous Biodiversity, due to be gazetted in December 2022.
- The National Policy Statement on Highly Productive Land is due to be gazetted later this year (2022).
- The proposed Otago Regional Policy Statement (pRPS), which has been notified and submissions have been received. However, a recent judicial review has directed the removal of the freshwater provisions and subsequent renotification of those provisions as a separate document. The pRPS remains referenced throughout this chapter, however, as the most recent indication of the "direction of travel" regarding management of natural and physical resources within the Otago region.
- The anticipated Otago Regional Land and Water Plan, which is due to be notified next year (2023) and which will implement the pRPS.
- Any shift in policy arising from the Conservation Law reform currently underway.

Recognising the dynamic nature of the current legislative and policy environment, the following section therefore outlines the focus area(s) or 'direction of travel' within the existing legislative and planning framework grouped by topic as relevant to the project, namely:

- Te Ao Māori
- Freshwater and Aquatic Ecology
- Indigenous Biodiversity and Terrestrial Ecology
- Natural Character, Landscapes and Features
- Social and Recreational Values
- Heritage
- Productive Soils
- Air Quality
- Natural Hazards
- Renewable Energy.

It then incudes a specific section on offsetting and compensation which is a concept relevant to each of the topic areas listed. The chapter concludes with an overview of the Conservation Act 1987 and the Conservation General Policy directions regarding specific obligations related to conservation land (some of which currently falls within the project area).

s 9(2)(g)(i)

[redacted]

s 9(2)(g)(i) [redacted]

[redacted]

18.1 Existing framework

18.1.1 Te Ao Māori

Table 18.1: Te Ao Māori source documents and notable project features

Source documents	Kāi Tahu ki Otago – Natural Resource Management Plan 2005
	All subsidiary RMA documents, including national and regional policy statements and regional and district plans
	The Otago Conservation Management Strategy 2016, and the Otago Regional Council Biosecurity Strategy
	Heritage New Zealand Pouhere Taonga Act 2014
Examples of notable project features	Mana whenua: Te Rūnanga o Ōtākou; Kāti Huirapa ki Puketeraki; and Hokonui Rūnaka
	Water bodies within the project area, including Lake Onslow, Mata-Au/Clutha River and Te Awa Makarara/Teviot River. Wetlands, including Fortification Creek wetland complex. Various other wāhi tūpuna.
	Indigenous species, which are regarded as taoka, and include: the Teviot flathead galaxias, koura, kākahi.
	Archaeological sites of significance around Lake Onslow.

Source: Te Rōpū Matatau

The relationship between takata whenua and the environment is recognised and acknowledged in multiple ways within the current legislative and planning environment. From the primary legislation which directs decision-makers to have regard to, or implement, the principles of Te Tiriti o Waitangi[289] through to the identification and protection of specific sites, species, resources and/or practices which hold specific value or importance to papatipu rūnaka, te ao Māori holds a vital space within the existing framework of environmental management.

As set out in the Consenting Strategy, that space is set to evolve substantially under the proposed reform of the RMA (and likely within other reform initiatives), with increasing recognition and adoption of mātauraka māori and māori concepts of, and aspirations for, environmental management (illustrated in Table 18.2 below), together with an expanded role for iwi authorities in decision-making.

289 Resource Management Act 1991, section 8

Table 18.2: Mātauraka māori and māori concepts of, and aspirations for, environmental management

Te Oranga o te Taiao	Used in the Exposure Draft for the new Natural and Built Environments Act. One of the purposes of that Act is to enable Te Oranga o te Taiao to be upheld including by protecting and enhancing the natural environment. Te Oranga o te Taiao is described as incorporating: • The health of the natural environment; • The intrinsic relationship between iwi and hapū and te taiao; and • The interconnectedness of all parts of the natural environment; and • The essential relationship between the health of the natural environment and its capacity to sustain all life.
Te Mana o te Wai	Founding kaupapa of the NPS-F. It encompasses six principles relating to the roles of tangata whenua and other New Zealanders in the management of freshwater. Those principles are: • Mana whakahaere: the power, authority and obligations of tangata whenua to make decisions in respect of the health and wellbeing of, and their relationship with, freshwater. • Kaitiakitanga: the obligation of tangata whenua to preserve, restore, enhance, and sustainable 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 wellbeing of freshwater now and in the future. • Stewardship: the obligation of all New Zealanders to manage freshwater in a way that ensures it sustains present and future generations. • Care and respect: the responsibility of all New Zealanders to care for freshwater in providing for the health of the nation. Hierarchy of obligations in Te Mana o te Wai that prioritises: • The health and wellbeing of water bodies and freshwater ecosystems; • The health needs of people; • The ability of people and communities to provide for their social, economic and cultural wellbeing, now and in the future.
Te Mana o te Taiao	Means the mana of the living environment, and is the title and founding concept of the Aotearoa New Zealand Biodiversity Strategy 2020. People are a part of nature and we can only thrive when nature thrives. Te Mauri Hikahika o te Taiao – the life force of nature is vibrant and vigorous.

Source: Te Rōpū Matatau

In practical terms, this recognition of Te Ao Māori and the relationship between takata whenua and the environment adds a critical layer of consideration for any project. The existing framework necessitates meaningful engagement with mana whenua (those who exercise kaitiakitaka or guardianship over a particular area) to understand the implications for Māori of the proposed use of that environment or resource. Those considerations encompass how the project might impact on those resources or practices of particular value to mana whenua, and where such impacts are adverse, whether and to what extent those impacts can be remedied. In some instances, and particularly where those adverse effects relate to spiritual matters such as a loss of mauri (life force) or wairua (spirit) associated with degradation or loss of a waterway it may not be possible to offset or compensate such losses.

In terms of the project area specifically (including the Mata-Au/Clutha River), the following papatipu rūnaka located in Otago hold shared authority and mana whenua status:

- Te Rūnanga o Ōtākou

- Kāti Huirapa ki Puketeraki
- Hokonui Rūnaka.

(together, Kā Rūnaka or mana whenua)

The values, aspirations and statements of intent of Kā Rūnaka in relation to the Otago region and its natural and physical resources are expressed in the various subsidiary RMA instruments and the Kāi Tahu ki Otago – Natural Resource Management Plan 2005, as well as (to varying degrees) in the relevant conservation and pest management strategies and plans.

Some extracts of those kaupapa which are considered of particular relevance to the project are set out below (although do not represent an exhaustive nor comprehensive list). Cultural values within the project area are also described in a Cultural Values Statement, provided by Aukaha on behalf of mana whenua (and included within **Volume Two**).

Whakapapa is central to the te ao Māori worldview, operating as the foundation on which all things are built. It connects Kāi Tahu (including Kā Rūnaka) to the mountains, forests, water and all the life supported by them, and that whakapapa connection is reflected in the attitudes towards the natural world and to resource management.[290]

From whakapapa, **kaitiakitaka** is the 'basic building block' of Kāi Tahu's relationship with the environment, informing the objectives of protecting the mauri and life-supporting capacity of the environment, and passing the environment on to future generations in an enhanced state.[291]

Ki uta ki tai underpins Kāi Tahu ki Otago's philosophy towards natural resource management. It recognises the interconnectedness of things where the effects on one part of the whole environment will be felt through the balance. Consequently, it contemplates the holistic management of interrelated environmental elements within and between catchments, from the air and atmosphere to the land and the coastal environment.[292]

Kāi Tahu ki Otago are **partners** with the Otago Councils in the management of natural resources, participating in the planning, implementation and monitoring of various objectives, policies and methods within environmental documents, and being consulted on key issues affecting mana whenua.[293]

Mahika kai is one of the cornerstones of Kāi Tahu's cultural identity. It refers to the customary gathering of food and natural materials and the places where those resources are gathered or produced. Maintaining mahika kia sites, gathering resources and continuing to practice the tikaka (beliefs, values and practices that guide appropriate ways of behaviour) that governs each resource, is an important means of passing on cultural values and mātauraka māori to the next generation.[294]

---

[290] Kāi Tahu ki Otago – Natural Resource Management Plan 2005, 3.3; Partially Operative Otago Regional Policy Statement 2019, Schedule 1A; Proposed Otago Regional Policy Statement 2021, page 50; Otago Conservation Management Strategy 2016, 1.4

[291] Kāi Tahu ki Otago – Natural Resource Management Plan 2005, 3.2; Partially Operative Otago Regional Policy Statement 2019, Schedule 1A, objective 2.1 and policy 2.1.2; Proposed Otago Regional Policy Statement 2021, page 51, ECO-O1, IM-P3; Central Otago District Plan, 3.2.1; Otago Conservation Management Strategy 2016, 1.4

[292] Kāi Tahu ki Otago – Natural Resource Management Plan 2005, 1.2; Partially Operative Otago Regional Policy Statement 2019, Schedule 1A; Proposed Otago Regional Policy Statement 2021, IM-M1(5), LF-WAI-P3, ECO-P10; Otago Conservation Management Strategy 2016, 113

[293] Partially Operative Otago Regional Policy Statement 2019, page 4, policy 2.1.2; Proposed Otago Regional Policy Statement 2021, MW-01, MW- P1, MW-P2, MW-M1 – M4, IM-M2

[294] Kāi Tahu ki Otago – Natural Resource Management Plan 2005, 5.5; Partially Operative Otago Regional Policy Statement, Schedule 1B – Kai Tahu Values; Proposed Otago Regional Policy Statement 2021, LF-WAI-P2, LF-VM-O2 – Clutha Mata-au FMU vision – (4); Otago Conservation Management Strategy 2016, 1.4.1.7; Central Otago District Plan, 3.2.5, policy 3.4.5; Otago Regional Plan: Water, 4.8

There are numerous **wāhi tūpuna** (ancestral landscapes), **wāhi tapu**, and **wāhi taoka** (including taoka (precious) species) throughout the Otago region, which, among other values, provide physical and emotional links to ancestors. These sites, areas and resources have already been threatened (and in some cases, destroyed by hydro projects). Those which remain should be protected.[295]

Water/wai plays a significant role in Kāi Tahu's spiritual beliefs and cultural traditions.[296] Through whakapapa, Kāi Tahu have an obligation to protect wai and all the life it supports. The condition of water is seen as a reflection on the condition of the people.

The identity of iwi, in other words, is bound to the water, and protecting the mauri of all water bodies is essential in the maintenance of that identity. To that end:

- The cross mixing of water between water bodies and catchments is identified as a threat to the mauri of those water bodies, and is opposed.[297]
- Aquatic pest species such as *Lagarosiphon major* threaten the availability and abundance of mahika kai. Their spread into water bodies should be halted.[298]
- Each water body has unique whakapapa and characteristics. The natural character of water bodies including wetlands and rivers should be preserved and protected from inappropriate use and development. Minimum flows of rivers should consider social and cultural needs as well as biophysical requirements.[299]
- Wetlands play a vital role in maintaining the health of water bodies and in supporting indigenous biodiversity. They are also critical for sustaining mahika kai and the wider health of ecosystems. They should be protected and enhanced to ensure that continuing role.[300]
- Effects associated with dam management in the Mata-Au/Clutha River catchment (flow issues, changes to waterways, habitat changes, inundation of values habitats, fish passage) must be addressed. Where the scale of effects is such that it cannot be addressed, papatipu rūnaka may advocate for declining consent.[301]

18.1.2 Freshwater and aquatic ecology

Table 18.3 Freshwater and aquatic ecology source documents and notable project features

Source documents	NPS-F and the NES-F
	The pRPS and the oRPS

[295] Kāi Tahu ki Otago – Natural Resource Management Plan 2005, 5.4; Partially Operative Otago Regional Policy Statement 2019, objective 2.2 and supporting policies, policy 5.2.3; Proposed Otago Regional Policy Statement 2021, page 52 - 53 HCV-WT including all objectives and policies; Central Otago District Plan, policy 3.4.2

[296] Kāi Tahu ki Otago – Natural Resource Management Plan 2005, 5.3, 10.2; Partially Operative Otago Regional Policy Statement 2019, policy 3.2.13; Proposed Otago Regional Policy Statement 2021, page 52, objectives and policies for LF-WAI; Central Otago District Plan, 3.2.4, policy 3.4.4; Otago Regional Plan: Water, 4.4 and 4.6

[297] Kāi Tahu ki Otago – Natural Resource Management Plan 2005, 5.3.4; Proposed Otago Regional Policy Statement 2021, page 87; Otago Regional Plan: Water, 4.13.4, objectives 5.3.2 and 6.3.5

[298] Kāi Tahu ki Otago – Natural Resource Management Plan 2005, 10.4.2. Otago Regional Council Biosecurity Strategy, 2.1; Proposed Otago Regional Policy Statement 2021, RMIA-MKB-I1

[299] Kāi Tahu ki Otago – Natural Resource Management Plan 2005, 5.3.2; Proposed Otago Regional Policy Statement 2021, LF-WAI-O1

[300] Kāi Tahu ki Otago – Natural Resource Management Plan 2005, page 63; Otago Regional Plan: Water, 4.13.6

[301] Kāi Tahu ki Otago – Natural Resource Management Plan 2005, 10.2.3; Central Otago District Plan, policy 3.2.5; Proposed Otago Regional Policy Statement 2021, LF-FW-09; Partially Operative Otago Regional Policy Statement, policy 3.2.15

	The Otago Regional Plan: Water (Water Plan), and the Central Otago District Plan (District Plan)
	The Otago Conservation Management Strategy 2016.
	Kāi Tahu ki Otago–Natural Resource Management Plan 2005
Examples of notable project features	Freshwater bodies: Lake Onslow, Mata-Au/Clutha River, Te Awa Makarara/Teviot River
	Approximately 1330ha of wetland vegetation, including 526ha of the nationally significant Fortification Creek wetland complex.
	Various aquatic species including the Teviot flathead galaxias, the dusky galaxias, koura, brown trout, *Potamogeton* species and *Myriophyllum* species, and 51 freshwater invertebrate species.
	Transfer of aquatic pest species: *Lagarosiphon major* from Mata-Au/Clutha River to Lake Onslow.

Source: Te Rōpū Matatau

The promulgation of the NPS-F and NES-F in recent years has marked a significant step-change in the management of freshwater in Aotearoa New Zealand. The scale and extent of degradation within freshwater bodies across the country and the resultant effects of that on the health of various eco-systems (including human health) has prompted the imposition of a significantly more stringent regime. Founded on the concept of Te Mana o te Wai, these documents acknowledge the fundamental importance of water and protecting its mauri or lifeforce. In doing so, the health and well-being of the wider environment is protected. As such, these documents focus on restoring and preserving the balance between water, the wider environment and the community.[302]

The NPS-F outlines the hierarchy of obligations within Te Mana o te Wai, which prioritises:

- The health and wellbeing of water bodies and freshwater ecosystems
- The health needs of people (such as drinking water)
- The ability of people and communities to provide for their social, economic and cultural wellbeing, now and in the future.303

As part of Te Mana o Te Wai, the NPS-F directs the active involvement of takata whenua in freshwater management throughout the regions, as well as the identification and provision for māori freshwater values.[304]

As national documents, both the NPS-F and the NES-F sit atop the RMA hierarchy, meaning they must be implemented through all subsidiary regional and district documents, and in the case of the NES-F, the specific rules of that document (which control activities relating to freshwater components) prevail. Of particular relevance to the project are the rules relating to activities within wetlands (such as the discharge of water) and fish passage. In general, those rules are strongly weighted towards protection of freshwater resources (particularly in the context of wetlands). In practical terms, these provisions (in combination with the broader policy support from the NPS-F) either prevent or impose significant requirements on activities which compromise those resources.

More broadly, the NPS-F and the pRPS (which must implement the NPS-F) set the following directions relevant to freshwater:

302 National Policy Statement for Freshwater Management 2020, 1.3(3), policy 1
303 National Policy Statement for Freshwater Management 2020, 1.3(5), objective 2.1
304 National Policy Statement for Freshwater Management 2020, 1.3(4), policy 2

- Consistent with Te Mana o te Wai, freshwater management within Otago will place the mauri of the water at the forefront of decision-making.[305] That involves an integrated approach to the management of freshwater which (inter alia):
  - enables mana whenua to exercise rakatirataka, manaakitaka and their kaitiakitaka duty of care and attention over the wai and all the life it support[306]
  - recognises and sustains connections and interactions between water bodies, and reflects that each waterbody has unique whakapapa and characteristics[307]
  - sustains and, wherever possible, restores the habitats of mahika kai and indigenous species[308]
  - manages the effects of use and development to maintain or enhance the health and wellbeing of freshwater.[309]
- **Natural inland wetlands** | There should be no further loss in the extent of these wetlands, their values are to be protected and their restoration is promoted.[310] As a result, there is no decrease in the range and diversity of indigenous ecosystem types and habitats within natural wetlands, nor any reduction in their ecosystem health, hydrological functioning, amenity values, extent or water quality. 'Protection' in this context is achieved by avoiding any reduction in the values or extent of natural wetlands except in certain circumstances (including where the 'offending' activity is necessary for the construction or upgrade of specified infrastructure).[311] Activities which fail to meet the parameters of those circumstances will not receive consent.
- **Preserving natural character of lakes and rivers and their beds and margins** | This is intended to be achieved by avoiding the loss of values or extent of a river, unless there is a functional need for the activity in that location, and the effects of the activity are first avoided, remedied or mitigated, and if that cannot be achieved, offset then compensated.[312] It will also be achieved by sustaining the form and function of the water body that reflects its natural behaviours.
- **Outstanding water bodies |** The pRPS directs the Otago Regional Council to map outstanding water bodies and identify their outstanding and significant values (which may include their ecological value as a habitat for Threatened species), and include provisions within regional plans to avoid adverse effects of activities on those values.[313]
- **Environmental outcomes, attribute states and limits** | These mechanisms must be set within the regional plan in relation to freshwater management units. Under the proposed RPS, these are set to ensure that the health and wellbeing of water bodies is maintained or, if degraded, improved, and that the habitats of indigenous species associated with water bodies are protected, including through provision of fish passage.[314]

---

305 National Policy Statement for Freshwater Management 2020, objective 2.1 and policy 1; Proposed Otago Regional Policy Statement 2021, LF-WAI-O1

306 Proposed Otago Regional Policy Statement 2021, LF-WAI-O1, LF-WAI-P2 and P3

307 Proposed Otago Regional Policy Statement 2021, LF-WAI-O1, LF-WAI- O1 and P3

308 Proposed Otago Regional Policy Statement 2021, LF-WAI-O1, LF-WAI-P3

309 Proposed Otago Regional Policy Statement 2021, LF-WAI-O1, LF-WAI-P3

310 National Policy Statement for Freshwater Management 2020, policy 6; Proposed Otago Regional Policy Statement 2021, LF-FW-P9

311 Proposed Otago Regional Policy Statement 2021, LF-FW-P9

312 National Policy Statement for Freshwater Management 2020, policy 7; Proposed Otago Regional Policy Statement 2021, LF-FW-O10, P13; Otago Regional Plan: Water, policy 5.4.8; objective 5.3.3

313 National Policy Statement for Freshwater Management 2020, policy 8; Proposed Otago Regional Policy Statement 2021, LF-FW-P12

314 National Policy Statement for Freshwater Management 2020, clauses 3.9 – 3.17; Proposed Otago Regional Policy Statement 2021, LF-FW-M6

As set out further in **Chapter 5: Freshwater**, Otago's waterbodies are recognised as a stronghold for various aquatic species, including the rare indigenous galaxiid species (such as the Threatened-Nationally Critical Teviot flathead galaxias found in the Te Awa Makarara/Teviot River). Protecting these freshwater habitats, including maintaining connections between them and migration routes is an essential part of the conservation focus for this area.[315] Environmental flow and level regimes within the new Otago Land and Water Regional Plan will be required to provide for the needs of indigenous fauna, including taoka species, and aquatic species associated with the water body.[316] Within the existing Regional Plan: Water, there is a strong policy direction towards retaining sufficient river flows to maintain their life-supporting capacity for aquatic ecosystems and their natural character.[317]

Finally, aquatic pest species are also recognised within the existing planning framework as threats to the health and natural character of waterbodies and the ecosystems that those water bodies support.[318] In response, the introduction of any such pest plant species which are identified in the Pest Management Strategy for Otago 2009 is prohibited under the Regional Plan, including *Lagarosiphon major.*[319]

In limited circumstances, there are exceptions to the freshwater provisions in the pRPS and the oRPS for significant infrastructure.[320] As described in further detail below, while those exceptions would remove the absolute requirement for avoiding adverse effects on those values of specific freshwater bodies, such infrastructure would still need to comply with a stringent effects management hierarchy which, under the pRPS, generally requires that:

- Adverse effects are avoided as a first priority or where practicable
- Where adverse effects (demonstrably) cannot be avoided, they are remedied and/or mitigated
- Where there are more than minor residual effects after avoidance, remediation and mitigation, they are offset
- If offsetting is not possible, then they are compensated for
- If compensation is not possible, then the activity is avoided.[321]

(together, the *effects management hierarchy*).

18.1.3 Indigenous biodiversity and terrestrial ecology

Table 18.4: Indigenous biodiversity and terrestrial ecology source documents and notable project features

Source documents	The NPS-F, the draft NPS-IB[322]
	The pRPS and the oRPS, and the District Plan
	Te Mana o te Taiao – Aotearoa New Zealand Biodiversity Strategy 2020
	Otago Conservation Management Strategy 2016

315 Otago Conservation Management Strategy 2016, pages 49, 114
316 Proposed Otago Regional Policy Statement 2021, LF-FW-M6
317 Otago Regional Plan: Water, objective 6.3.1
318 Partially Operative Otago Regional Policy Statement, policy 3.2.14; Proposed Otago Regional Policy Statement 2021, SRMR-I3; Otago Pest Management Plan 2019
319 Otago Regional Plan: Water, policy 8.7.2 and Rule 13.6.1.1
320 Partially Operative Otago Regional Policy Statement 2021, policy 4.3.4
321 Partially Operative Otago Regional Policy Statement, policy 4.3.2; Proposed Otago Regional Policy Statement, LW-FW-P9, ECO-P4, LF-P12
322 Ministry for the Environment (2022), National Policy Statement for Indigenous Biodiversity - exposure draft (June 2022).

	Kāi Tahu ki Otago – Natural Resource Management Plan 2005
Examples of notable project features	Area of significant natural value within the proposed inundation area. • At least 17 indigenous vascular and non-vascular plant species were observed that are classified as Nationally Threatened or At Risk. These include one Threatened-Nationally Critical species (*Pseudognaphalium ephemerum*) and one Threatened-Nationally Endangered species (*Hypericum rubicundulum*). • 21 indigenous bird species, including four Nationally Threatened and four At Risk species. • A new population of burgan skink (Threatened-Nationally Endangered). • 61 taxa of terrestrial invertebrates. Habitats for terrestrial invertebrates included tussock grassland, wetland, rockland, indigenous shrubland, exotic forest and pasture.

Source: Te Rōpū Matatau

Protecting areas of significant indigenous vegetation and significant habitats of indigenous fauna is identified as a matter of a national importance with the RMA, and is an outcome which has been targeted to varying degrees of specificity and sophistication within the subsidiary planning instruments. As the health of Aotearoa New Zealand's indigenous biodiversity has faced increasing pressure from human activity, invasive pest species and climate change,[323] the effectiveness of those existing controls has come under increased scrutiny.

In 2020, the DOC released Te Mana o te Taiao, a national strategy for the protection, restoration and sustainable use of biodiversity (particularly indigenous biodiversity) over the next 30 years. The Strategy aims to ensure that Aotearoa New Zealand's ecosystems, indigenous species, and habitats are thriving, people are connected to nature, and mana whenua are exercising their full role as rakatira and kaitiaki of indigenous biodiversity.[324] Within Otago specifically, the Conservation Management Strategy aims to ensure that (among numerous other outcomes):

- The diversity of natural heritage is maintained and restored, giving priority to specific ecosystems, species, and geological features. These include red tussock wetlands and *Schoenus pauciflorus* tussock land found within the Manorburn Conservation Area, and Threatened and At Risk species including the kettlehole cudweed *Pseudognaphalium ephemerum*, and the burgan and Otago skinks.[325]
- Indigenous vegetation is protected and is being restored on the margins of lakes, rivers and wetlands, creating new wildlife habitats and corridors, and enhancing the landscape and aquatic values.[326]
- Tussock grasslands are valued and protected for the role they play in water storage and yield and in protecting catchment water quality and quantity.[327]
- Otago's terrestrial ecosystems and their species are thriving at a self-sustaining level. Of particular importance is the lizard fauna, including the threatened grand and Otago skinks of Central Otago and the moko kākāriki/jewelled gecko, and the main threatened dryland plant species.[328]

The ambitious (non-statutory) aspirations of the Te Mana o te Taiao Biodiversity Strategy and the Otago Conservation Management Strategy align closely with the provisions of the draft

323 Aotearoa New Zealand Biodiversity Strategy - Te Mana o Te Taiao 2020; Draft National Policy Statement on Indigenous Biodiversity 2019, page 4
324 Aotearoa New Zealand Biodiversity Strategy - Te Mana o Te Taiao 2020, 2.2
325 Otago Conservation Management Strategy 2016, objective 1.5.1.1
326 Otago Conservation Management Strategy 2016, page 117
327 Otago Conservation Management Strategy 2016, page 117
328 Otago Conservation Management Strategy 2016, page 22

NPS-IB, which is set to be gazetted later this year (2022). The objective of that document centres around the protection, maintenance and restoration of indigenous biodiversity in a manner which recognises takata whenua as kaitiaki and people and communities as stewards of indigenous biodiversity, and provides for the wellbeing of people and communities now and into the future.[329] 'Maintenance' in that context requires at least no reduction in:

- The size of the populations of indigenous species
- Indigenous species occupancy across their natural range
- The properties and function of ecosystems and habitats
- The full range and extent of ecosystems and habitats
- Connectivity between and buffering around, ecosystems
- The resilience and adaptability of ecosystems.[330]

The draft NPS proposes to achieve this objective and its supporting policies through provisions within subsidiary regional and district plans which seek to restrict, or in some cases, effectively prevent, activities that adversely affect indigenous biodiversity, particularly where that is located in 'significant natural areas'. In particular, the draft NPS-IB instructs the preparation of a rule framework that requires the avoidance (prevention) of adverse effects on a range of aspects of indigenous biodiversity, including any reduction in the population size or occupancy of a Threatened, At Risk declining species that uses any part of a significant natural area for its life-cycle. 'Adverse effects"' in the context of that draft NPS-IB is expansively defined, encompassing (inter alia) loss of ecosystem representation or extent, fragmentation of loss of buffering or connectivity within and between habitats or ecosystems, the reduction in population size, pest or fauna incursions, a reduction in people's ability to connect with and benefit from indigenous biodiversity, and the degradation of mauri.[331]

Otago is one of the most biodiverse regions in Aotearoa New Zealand, with high levels of endemism. In that context, the pRPS has sought to reflect the aspirations of the Biodiversity Strategy and the draft NPS-IB by:

- Requiring and providing the framework for identification of significant natural areas throughout the Otago region[332]
- Establishing a strong direction towards protecting significant natural areas of indigenous biodiversity, and ensuring that Otago's indigenous biodiversity is thriving and healthy and any decline in quality, quantity and diversity is halted.[333]

In the pRPS, that protection outcome is primarily achieved through the requirement to avoid adverse effects from activities that result in:

- Any reduction in the area or values of significant natural areas or indigenous species or ecosystems that are taoka (even if those values are not themselves significant)
- Any loss of Kāi Tahu values.[334]

[329] Ministry for the Environment (2022), National Policy Statement for Indigenous Biodiversity - exposure draft (June 2022), objectives 1 – 6

[330] Ministry for the Environment (2022), National Policy Statement for Indigenous Biodiversity - exposure draft (June 2022), 1.5(3)

[331] Ministry for the Environment. (2022). National Policy Statement for Indigenous Biodiversity - exposure draft (June 2022), 3.10.

[332] Proposed Otago Regional Policy Statement 2021, ECO-P2

[333] Proposed Otago Regional Policy Statement 2021, ECO-P3 and P4

[334] Proposed Otago Regional Policy Statement 2021, ECO-P3

In practical terms, those provisions would operate to prevent an activity from proceeding within a significant natural area where it could not avoid the adverse effects described above.

As with freshwater, however, there is a specific exception to that position which aims to accommodate specific kinds of infrastructure.[335] Again, while that exception would remove the absolute requirement for avoiding adverse effects on those values of significant natural areas, such infrastructure would still need to comply with a similarly stringent effects management regime.

For their parts, the oRPS and the District Plan take a more general approach to the management of indigenous biodiversity (outside of the coastal environment), focused on maintaining or enhancing ecosystem health and indigenous biodiversity, and the values which contribute to an indigenous area or habitat retaining particular significance. [336]As part of that, the oRPS aims to control adverse effects of pest species, including by preventing their introduction and reducing their spread.[337] Implementation of that outcome is supported by the directions within the Otago Regional Pest Management Plan 2019.

18.1.4 Landscape

Table 18.5: Landscape source documents and notable project features

Source documents	The pRPS and the oRPS, and the District Plan
	Otago Conservation Management Strategy
Examples of notable project features	Within the Upper Manorburn/Lake Onslow Landscape Management Area. Adjacent to an Outstanding Natural Landscape.
	Nationally significant wetlands within the inundation area

Source: Te Rōpū Matatau

Like indigenous biodiversity, the protection of outstanding natural landscapes and features is recognised as a matter of national importance within the RMA and its subsidiary documents. Landscapes are also an important part of conservation management both for their intrinsic value, and the role they have in supporting eco-systems. The Otago Region is specifically recognised for its distinct character and a vast diversity of unique landscapes which contribute to Aotearoa New Zealand's international identity and reputation, as well as the wellbeing of Otago's communities.[338]

At a district level, these landscapes (including the Upper Manorburn/Lake Onslow Landscape Management Area) are identified as possessing a number of important attributes which warrant protection from inappropriate use, subdivision, and development, including their:

- Uniqueness within the district, region, or Aotearoa New Zealand
- Representation of a particular landform occurring within the district which gives it its particular character
- Cultural or historic significance
- High natural character values and high landscape quality that can be distinguished from the general landscapes of Central Otago.[339]

335 Proposed Otago Regional Policy Statement 2021, ECO- P4, ECO-P6

336 Partially Operative Otago Regional Policy Statement 2016, policy 3.1.9; policies 3.2.1 – 3.2.2; Central Otago District Plan, policy 4.4.7; objectives 4.3.1 and 4.3.8

337 Partially Operative Otago Regional Policy Statement 2016, policy 5.4.5

338 Central Otago District Plan, issues 4.2.1 – 4.2.2; Otago Conservation Management Strategy 2016, pages 18 – 19, Appendix 9

339 Central Otago District Plan, policy 4.4.1

Protection of these landscapes from inappropriate use, subdivision, and development is achieved in the District Plan via a consenting pathway that enables consideration of the impact of any activity on the values of those landscapes. Under the oRPS, those values are to be maintained for outstanding landscapes outside of the coastal environment.[340] The proposed RPS intends a more restrictive approach to 'protection' which will require the inclusion of a rule framework that achieves the protection of outstanding natural landscapes by avoiding adverse effects on values that contribute to that landscape being considered outstanding, even if those values themselves are not outstanding.[341] Where activities cannot avoid adverse effects on those values, these provisions would operate to prevent their establishment. As with natural wetlands and significant natural areas, the pRPS provides a lower threshold for specific kinds of infrastructure (discussed below).[342]

18.1.5 Social and recreational values

Table 18.6: Social and recreation values source documents and notable project features

Source documents	The pRPS and oRPS, and the District Plan
	The Otago Conservation Management Strategy 2016
	Kāi Tahu ki Otago – Natural Resource Management Plan 2005
Examples of notable project features	Communities of the Central Otago and Clutha Districts, including mana whenua. Economy based on agriculture, horticulture, tourism and construction. Long history of hydro-electricity investigations and developments.
	Numerous recreation activities within the project area including angling, cycling, four-wheel driving, swimming, hunting, and boating.
	Numerous sources of mahika kai: Te Awa Makarara and Lake Onslow

Source: Te Rōpū Matatau

The existing legislative and planning framework recognises different ways in which the management of natural and physical resources can affect social wellbeing, including the:

- Protection of landscapes, taoka and water bodies which hold intrinsic importance for a community's identity and expression
- Provision of economic opportunity and resilience for communities through the delivery of infrastructure, housing and vibrant commercial and industrial centres which offer employment
- Management of natural hazards which pose risk to life and livelihoods.[343]

In general terms, the district and regional planning documents seek to enable these outcomes while balancing the health of the natural environment. They do so primarily by requiring decision-makers to consider the impacts of a particular use on the social wellbeing of communities. However, in instances where a proposal is located in a particularly sensitive, significant or degraded part of the natural environment (for example, natural wetlands or significant natural areas), the provisions within these planning documents indicate that the potential social benefits of a proposal will generally be subservient to the need for environmental protection.

[340] Partially Operative Otago Policy Statement 2019, policies 3.2.3 and 3.2.4

[341] Proposed Otago Regional Policy Statement 2021, NFL-P2

[342] Proposed Otago Regional Policy Statement 2021, EIT-EN-P6

[343] Partially Operative Otago Regional Policy Statement 2019, policies 1.1.2, policy 4.1.5; Proposed Otago Regional Policy Statement 2021, HAZ-NH-P1 – 10, IM-P2; ECO-P4; Central Otago District Plan, policies 3.2.2 and 3.2.3, 13.4.1; Otago Conservation Management Strategy 2016, page 114

The recreation value of natural resources within Otago is also recognised throughout the RMA planning documents and within the various conservation strategies.[344] Fishing, tramping, jet boating, mountain biking and skiing area are all recreation opportunities which are carried out throughout Otago, and which rely on the health of the natural environment.[345] Maintaining and enhancing the quality of those resources for recreational uses is one of the key objectives within the rural environment of Central Otago, as is the maintenance and improvement of public access to those resources. Pest management, protecting indigenous biodiversity, and enhancing water quality are all features of the regulatory framework which aim to achieve this objective.[346] The extent to which a proposal adversely affects these features, and therefore the overall recreation value of a resource, will be a relevant consideration in any assessment of that proposal.[347]

18.1.6 Heritage

Table 18.7: Heritage source documents and notable project features

Source documents	Heritage New Zealand Pouhere Taonga Act 2014
	Kāi Tahu ki Otago – Natural Resource Management Plan 2005
	The pRPS and the oRPS, and the District Plan
Examples of notable project features	Various recorded archaeological sites and features throughout the Lake Onslow area

Source: Te Rōpū Matatau

The protection of historic heritage from inappropriate subdivision, use and development is another matter of national importance under the RMA, which decision-makers must recognise and provide for when exercising functions and powers under that statute.[348]

The Otago planning and conservation documents recognise the contribution of Otago's unique historic heritage to the region's character, sense of identity and social, cultural and economic wellbeing and aims to preserve that for future generations.[349] That historic heritage comprises residential and commercial buildings and structures, archaeological sites including those of specific importance to takata whenua, pastoral sites, ruins, and trees.

The oRPS and pRPS impose a rule framework for the protection of historic heritage by requiring the avoidance of adverse effects on areas or places with special or outstanding historic heritage values or qualities, and the avoidance of *significant* adverse effects for those areas and places of lesser historic significance.[350] For the Central Otago district specifically, the rich and varied array of historic heritage is recognised for its substantial contribution to the character and amenity of the area.[351]

344 Central Otago District Plan, objective 4.3.4; Partially Operative Otago Regional Policy Statement 2019, policy 3.1.1; Proposed Otago Regional Policy Statement 2021, page 135; Otago Conservation Management Strategy 2016, 1.5.3

345 Otago Conservation Management Strategy 2016, page 23

346 Partially Operative Otago Regional Policy Statement 2019, policy 5.4.5, Otago Pest Management Plan 2019

347 Also refer Resource Management Act 1991, section 7(c)

348 Resource Management Act 1991, section 6(f).

349 Partially Operative Otago Regional Policy Statement 2019, policy 4.5.1, 5.2.1, and Schedule 5; Proposed Otago Regional Policy Statement 2021, HCV-HH-O3; Central Otago District Plan, objectives 14.3.1 – 14.3.4; Otago Conservation Management Strategy 2016, 1.5.2

350 Partially Operative Otago Regional Policy Statement 2019, policy 5.2.3; Proposed Otago Regional Policy Statement 2021, HCV-HH-P5

351 Central Otago District Plan, objectives 14.3.1 – 14.3.4, policies 14.4.7 and 14.4.8

Alongside the specific planning assessment requirements, the Heritage New Zealand Pouhere Taonga Act 2014 requires that archaeological authorities are obtained for activities which may modify or destroy the whole or any part of an archaeological site.[352] In assessing any application for an authority, Heritage New Zealand may consider the historic and cultural heritage value of the site and any other factors justifying its protection, and the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, wāhi tūpuna, wāhi tapu and other taoka.[353]

18.1.7 Productive soils

Table 18.8: Productive soils source documents and notable project features

Source documents	The discussion document for the proposed National Policy Statement on Highly Productive Land
	The pRPS and the oRPS, and the District Plan
Examples of notable project features	Small areas of Land Use Classification 3 soils within the s 9(2)(i) offtake option areas,

Source: Te Rōpū Matatau

The importance of productive or versatile soils for the healthy functioning of eco-systems is also recognised throughout the relevant RMA documents.[354]

Within the Central Otago District, there are areas which, because of their particular soil characteristics and qualities in combination with the local climate and irrigation, are considered to warrant specific protection to ensure their life-supporting capacity for current and future generations. Under the proposed RPS, those areas are to be identified according to their:

- Capability and versatility to support primary production based on the Land Use Capability classification system
- Suitability of the climate for primary production
- Size and cohesiveness of the area of land for use for primary production.[355]

Under the oRPS, the criteria for significant soils identification include the Land Use Capability classification, and the significance of the soil for primary production, providing contaminant buffering, filtering services, water storage or flow retention services.[356]

Where highly productive soils are identified according to that assessment under the pRPS, their use is to be prioritised for primary production over other land uses.[357] More broadly, the mauri, health and productive potential of soils is to be maintained in order to sustain health soil biological activity and diversity, soil structure and soil fertility.

18.1.8 Air quality

Table 18.9: Air quality source documents and notable project features

Source documents	The pRPS and the oRPS, the Regional Plan: Air, and the District Plan.
	The Otago Air Quality Strategy, Otago Regional Council: The State and Trends of Air Quality in the Otago Region

352 Heritage New Zealand Pouhere Taonga Act 2014, section 42
353 Heritage New Zealand Pouhere Taonga Act 2014, section 59
354 Partially Operative Otago Regional Policy Statement 2019, policies 3.1.7, 3.2.17 – 3.2.18; Proposed Otago Regional Policy Statement 2021, LF-LS-O11, LF-LS-P19
355 Proposed Otago Regional Policy Statement 2021, policy LF-LS-P19
356 Partially Operative Otago Regional Policy Statement 2019, policy 3.1.7
357 Proposed Otago Regional Policy Statement 2021, policy LF-LS-P19

Examples of notable project features	Air discharges during construction

Source: Te Rōpū Matatau

Protecting human health, amenity, mana whenua values and the life-supporting capacity of eco-systems is the key driver of the various objectives, policies and rules within the relevant Air Quality Strategy and RMA planning documents.[358] Good ambient air quality is to be maintained by ensuring discharges to air comply with ambient air quality limits where they have been set, and avoiding discharges to air which:

- Cause offensive, objectionable, noxious or dangerous effects;
- Adversely affect mana whenua values.

18.1.9 Natural hazards

Table 18.10: Natural hazards source documents and notable project features

Source documents	The pRPS and the oRPS, and the District Plan.
Examples of notable project features	Small mass movement areas identified downstream of the Onslow dam, potentially active faults, landslide features near the proposed tunnel outlet features at Lake Roxburgh, flooding in and adjacent to the Mata-Au/Clutha River

Source: Te Rōpū Matatau

Managing significant risks from natural hazards is identified within the RMA as a matter of national importance, which all decision-makers must recognise and provide for when managing the use, development and protection of natural and physical resources.

'Natural hazards' are defined within the RMA as "any atmospheric or earth or water related occurrence (including earthquake, erosion, landslip, subsidence, sedimentation, wind, drought, fire or flooding) the action of which adversely affects or may adversely affect human life, property or other aspects of the environment."[359]

Responsibility for managing natural risk in the RMA context lies with territorial authorities[360]. Within its District Plan, the Central Otago District Council has focused on reducing the effects or impact of natural hazards by prevention measures, effectively excluding certain types of development or imposing controls on development in areas subject to or likely to be affected by hazards. In particular, the policy focus of the District Plan is on:

- Restricting the erection of buildings in areas where there is a reasonable probability that a hazard may cause material damage.[361]
- Ensuring that the location, design and/or operation of land use activities does not increase the intensity and frequency of existing hazards unless such adverse effects can be avoided, remedied or mitigated.[362]

From the Regional Council perspective, both the oRPS and the pRPS adopt a tiered approach to the management of natural hazards, based on the relative level of risk. For new activities that result in significant risk from natural hazards, the approach in both documents is to

358 Partially Operative Otago Regional Policy Statement 2019, policy 3.1.6; Proposed Otago Regional Policy Statement 2021, AIR-O1, AIR-P1; Otago Regional Council. (2021). *State and Trends of Air Quality in the Otago Region* 2010- 2019

359 Resource Management Act 1991, section 2

360 Resource Management Act 1991, section 31

361 Central Otago District Plan, Policy 17.4.3

362 Central Otago District Plan, Policy 17.4.4

avoid/prevent those activities from establishing. For lower risk levels, the approach is to minimise identified risks, or maintain them where they are already acceptable.

18.1.10 Renewable energy

Table 18.11: Renewable energy source documents and notable project features

Source documents	The National Policy Statement on Renewable Electricity Generation (NPS-REG)
	The pRPS and oRPS, and the District Plan
Examples of notable project features	The project would be a significant generator of electricity, utilising a renewable resource – water.

Source: Te Rōpū Matatau

The effects of climate change and the benefits to be derived from the use and development of renewable energy are both matters to which all decision-makers under the RMA are required to have particular regard.[363] They are, in other words, important considerations in achieving the sustainable management of natural and physical resources. In recognition of that and the significance of renewable energy projects generally, the NPS-REG was promulgated in 2011. It recognises that the contribution of renewable electricity generation, regardless of scale, towards addressing the effects of climate change plays a vital role in the wellbeing of Aotearoa New Zealand, its people and the environment.[364] To that end, it seeks to enable an increase in the proportion of the country's electricity generated from renewable sources. As set out in the Consenting Strategy however, the NPS-REG also recognises that that increase may also result in conflicts with other considerations of national significance within the RMA context.[365] Its provisions seek to address that conflict in the following two main ways:

- By directing decision-makers to have particular regard to the importance of renewable electricity generation, and the logistical and technical constraints and challenges of developing, operating and maintaining such activities.[366]
- By directing decision-makers to have regard to offsetting or environmental compensation measures where residual environmental effects of renewable electricity generation cannot be avoided, remedied or mitigated.[367]

Those directions and the provisions of the NPS-REG more broadly are particularised within the oRPS, the pRPS and the District Plan. In the case of the District Plan, issues of conflict between the aspirations of increasing renewable power generation and the potential adverse effects of doing so are addressed in reasonably general terms – providing for those activities while ensuring their adverse effects are avoided, remedied or mitigated.[368]

The oRPS, and pRPS in particular, are significantly more directive. As set out further below, they provide a specific pathway for renewable electricity generation activities through what, for most other activities, would amount to environmental bottom lines (or at least significant environmental protection) for certain freshwater bodies and indigenous biodiversity.[369] That

[363] Resource Management Act 1991, sections 7(i) and (j)
[364] National Policy Statement on Renewable Electricity Generation 2011, preamble
[365] National Policy Statement on Renewable Electricity Generation 2011, preamble
[366] National Policy Statement on Renewable Electricity Generation 2011, policies A, B and C1
[367] National Policy Statement on Renewable Electricity Generation 2011, policy C2.
[368] Central Otago District Plan, policy 13.4.7
[369] Partially Operative Otago Regional Policy Statement 2019, policies 4.4.1, 4.3.2 and 4.3.4

pathway, however, still requires compliance with a strict effects management hierarchy, which may still impose potentially significant technical and operational constraints.[370]

18.1.11 Offsetting and compensation

Table 18.12: Offsetting and compensation source documents

Source documents	The NPS-F, and the draft NPS-IB
	The pRPS and the oRPS

Source: Te Rōpū Matatau

Decision-makers on resource consent applications are required by the RMA to have regard to any measure proposed or agreed to by the applicant to offset or compensate for any adverse effects on the environment.[371]

In considering this matter, the courts have established some important parameters/considerations around what constitutes a genuine offset or compensation:

- Biodiversity offsets will be inappropriate for certain ecosystem or habitat types where, due to the rarity or value, their clearance or allowance of adverse impacts would not be acceptable under any circumstances.[372]
- The test for environmental compensation is whether it is reasonably related to the natural and physical resources being used in the application.[373]

Within that context, the NPS-F, the oRPS and the pRPS include specific directions around when offsetting and compensation can be employed in order to receive specific policy support. Those scenarios are limited to:

- Specific activities which reduce the values or extent of natural wetlands (the pRPS);[374]
- Activities which result in the loss of values or extent of a river (the pRPS);[375]
- Specific activities which adversely affect significant natural areas or indigenous species and ecosystems that are taoka (the oRPS and the pRPS);[376]
- A proposed activity that provides or will provide enduring regionally or nationally significant mitigation of climate change impacts with commensurate benefits for the well-being of people and communities and the wider environment (the pRPS).[377]

In general terms, where an activity affects indigenous biodiversity, offsetting and compensation will not be available as an option (or more particularly, receive specific policy support) where (inter alia):

- The activity results in the loss of any individuals of Threatened taxa under the New Zealand Threat Classification System, or any reasonably measurable loss within the ecological district to an At Risk-Declining taxon (offsetting).
- The activity results in:

---

370 Partially Operative Otago Regional Policy Statement 2019, policy 4.3.4, policy 4.4.1; Proposed Otago Regional Policy Statement 2021, EIT-EN-P6

371 Resource Management Act 1991, section 104(1)(ab)

372 *Oceana Gold (New Zealand) Limited v Otago Regional Council* [2019] NZENVC 41 at [93]

373 *Upper Clutha Tracks Trust v Queenstown Lakes DC* [2012] NZEnvC 43

374 Proposed Otago Regional Policy Statement 2021, LF-FW-P9

375 Proposed Otago Regional Policy Statement 2021, LF-FW-P13

376 Partially Operative Otago Regional Policy Statement 2019, policy 4.3.4, policy 5.4.6; Proposed Otago Regional Policy Statement 2021, ECO-P4, ECO-P6, EIT-EN-P6, IM-P12, EIT-INF-P13(2)

377 Proposed Otago Regional Policy Statement 2021, IM-P12

- the loss of any indigenous taxon (excluding freshwater fauna and flora) or of any ecosystem type from an ecological district; or
- the removal or loss of viability of habitat of a Threatened or At Risk indigenous species of fauna or flora under the New Zealand Threat Classification system; or
- the removal or loss of viability of a naturally rare or uncommon ecosystem type that is associated with indigenous vegetation or habitat of indigenous fauna; or
- worsening of the New Zealand Threat Classification System conservation status of any Threatened or At Risk indigenous fauna (compensation).[378]

There are a range of other criteria within the oRPS and pRPS that must be met in order to receive policy support for biodiversity offsetting and compensation (refer **Appendix B of Volume Two**).

As set out further below, where offsetting and compensation is not available in terms of the RPS requirements, the policy direction shifts in the case of some activities to avoid their establishment altogether.

18.2 Analysis

In simple terms, the existing statutory and regulatory framework which would apply to the project aims to prioritize protection of the most sensitive and/or significant aspects of the natural environment, including freshwater resources, indigenous biodiversity, and outstanding landscapes and waterbodies. All of these aspects are encountered to varying degrees within the project area.

Although there are some differences in approach between the RMA documents (particularly the oRPS and the pRPS), in general, their provisions operate to prevent or highly constrain activities that would adversely affect these natural resources and their values. That is primarily achieved through the use of 'avoidance' policies in respect of any adverse effects on those resources, which effectively establish a form of environmental bottom line. Where an activity cannot meet those policies, it is highly unlikely that it can lawfully be granted consent.

As noted above, however, more recent RMA documents, and the pRPS in particular, recognise that there are a number of activities which are sufficiently important to the functioning of society so as to warrant greater accommodation than what would normally be afforded under this strict 'avoidance' position. Put another way, because of their importance (and in some cases, functional constraints), these activities are not limited to the same requirement to simply avoid adverse effects on those sensitive/significant aspects of the natural environment. Rather, where those effects cannot be avoided, the planning framework provides an alternative pathway for considering and managing the effects of those activities – mitigation, remediation, offsetting and compensation.

Helpfully for the project, renewable electricity generation, regionally and nationally significant infrastructure, and proposals which 'provide enduring regionally or nationally significant mitigation of climate change impacts' are all examples of activities which are given such a pathway within the pRPS (and the oRPS to a slightly lesser extent).[379]

The alternative approach for renewable electricity generation activities as prescribed by the pRPS is summarised in Table 18.13. In short, it absolves renewable electricity generation activities (which are of national or regional significance) from the absolute requirement to avoid

[378] Partially Operative Otago Regional Policy Statement, policy 5.4.6A; Proposed Otago Regional Policy Statement 2021, APP3 and APP4.

[379] Proposed Otago Regional Policy Statement 2021, IM-P12, ECO-P4, EIT-INF-P13(2); Partially Operative Regional Policy Statement, policy 4.3.4

adverse effects on most of those key natural resources – wetlands, indigenous biodiversity, outstanding landscapes. Consequently, where avoidance cannot be achieved, it provides the applicant with the opportunity to remedy, mitigate and/or minimise those adverse effects, or offset or compensation, where possible, provided the following evidential burden is met:

- Consideration of alternative sites, methods or designs which would reduce adverse effects
- Design and operational changes and/or accommodations to address adverse effects
- Significant offsetting and compensation when those adverse effects cannot be avoided, remedied or mitigated.[380]

Table 18.13: Proposed Otago Regional Policy Statement – Renewable Electricity Generation Activities Management Approach

	Approach	
1	Avoid as the first priority locating infrastructure in all of the following: • Significant natural areas • Outstanding natural features and landscapes • Natural wetlands • Outstanding water bodies • Area of high or outstanding natural character • Areas or places of significant or outstanding historic heritage • Wāhi tapū, wāhi taoka and areas with protected customary rights, and • Areas of high recreational and high amenity value.	
2	If it is not possible to avoid locating in the areas listed above because of the functional or operational needs of the infrastructure, manage the adverse effects in accordance with (3) below. • ‘Functional need’ means 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. • ‘Operational need’ means the need for a proposal or activity to traverse, locate or operate in a particular environment because of technical, logistical or operational characteristics or constraints. Note requirement (5) below – consideration of alternatives.	
3	For nationally or regionally significant infrastructure, adverse effects will be managed accordingly:	
	In significant natural areas (indigenous biodiversity)	• avoid adverse effects as a first priority; • where adverse effects demonstrably cannot be completely avoided, they are remedied; • where adverse effects cannot be completely avoided or remedied, they are mitigated; • where there are residual adverse effects after avoidance, remediation and mitigation then the residual adverse effects are offset in accordance with APP3 (**Appendix B**); and • if biodiversity offsetting is not possible then the residual adverse effects are compensated for in accordance with APP4 (**Appendix B**); • if the adverse effects cannot be compensated for in accordance with APP4, then the activity is avoided.
	In natural wetlands	In accordance with the NES-F. We understand this to mean that any applicant must demonstrate that: • The activity is necessary for the construction or upgrade of specified infrastructure (i.e. large-scale renewable electricity generation activities); • The specified infrastructure will provide significant national or regional benefits; • There is a functional need for the specified infrastructure in that location.

[380] Proposed Otago Regional Policy Statement 2021, IM-P12, EIT-INF-P13

	Approach	
		• The adverse effects of an activity on the extent of values of a wetland or river (including cumulative effects and loss of potential value) must be managed in accordance with the following approach: adverse effects are avoided where practicable; where adverse effects cannot be avoided, they are minimized where practicable; where adverse effects cannot be minimized, they are remedied where practicable; where more than minor residual adverse effects cannot be avoided, minimized, or remedied, aquatic offsetting is provided; and if aquatic compensation is not appropriate, then the activity itself is avoided.
	In outstanding water bodies	Avoid adverse effects on the significant and outstanding values of outstanding water bodies.
	In other areas listed in (1) above	Minimize the adverse effects of the infrastructure on the values that contribute to the area’s importance.
4	Have specific regard to the extent and magnitude of the activity’s adverse effects on the environment and the degree to which unavoidable adverse effects can be remedied or mitigated, or residual adverse effects are offset or compensated for.	
5	Consider alternative sites, methods and designs, and offsetting or compensation measures (in accordance with any specific requirements for their use within the RPS), where adverse effects are potentially significant or irreversible.	

Source: Te Rōpū Matatau

18.3 Conservation land

Table 18.14: Conservation land source documents and notable project features

Source documents	The Conservation Act 1987
	The Conservation General Policy, and the Otago Conservation Management Strategy 2016
Examples of notable project features	Part of the Manorburn Conservation Area would be inundated as part of expanding Lake Onslow (the upper reservoir). Inundation would constitute disposal of that land.
	The existing marginal strips in and around Lake Onslow would be inundated. New marginal strips would likely need to be set aside under the Conservation Act 1987.
	There are other flora and fauna within the Project Area which are managed under the Conservation Act 1987, including various indigenous freshwater fish species, and other live aquatic life.

Source: Te Rōpū Matatau

The Conservation Act 1987 imposes specific additional obligations on activities undertaken on conservation land. Statutory powers in relation to the use of those areas must be exercised in accordance with the Conservation General Policy and any applicable conservation management strategies or management plans approved under the Conservation Act 1987.[381]

The Conservation General Policy includes specific guidance on the instances when disposal (in this instance including inundation) of conservation areas (such as the Manorburn Conservation Area and the marginal strips around the Upper Reservoir) is appropriate. It currently provides that:

- Land disposal may be considered where the legislation to which it is subject allows for disposal and the land has no, or very low, conservation values[382]
- Subject to the above policy, land disposal should not be undertaken where the land in question either:
  - has international, national, or regional significance
  - is important for the survival of any threatened indigenous species; or
  - represents a habitat or ecosystem that is under-represented in public conservation lands[383]

As set out in the Consenting Strategy, if disposal of conservation land is to occur in accordance with the Conservation Act 1987, then these criteria within the General Policy must be met in order.[384] As also discussed in that Strategy, however, if the project constitutes Government work, then an alternative pathway may be available through the setting aside of conservation areas for the project under section 52 of the Public Works Act 1981 (PWA).[385] That pathway is still subject to the consent of the Minister for Conservation – an exercise of power which, while originating under the PWA, will still be shaped significantly by the conservation purposes of the Conservation Act 1987 and the directions of the Conservation General Policy.

381 Conservation Act 1987, section 17A. Refer *Hawke's Bay Regional Investment Company Limited v Royal New Zealand Forest and Bird Protection Society of New Zealand Inc* [2017] NZSC 106, [130] – [134].

382 Conservation General Policy,6(c)

383 Conservation General Policy, 6(d)

384 *Hawke's Bay Regional Investment Company Limited v Royal New Zealand Forest and Bird Protection Society of New Zealand Inc* [2017] NZSC 106, [130] – [134]

385 Conservation Act 1987, section 16; subject to the Public Works Act 1981, no conservation area…shall be disposed of except in accordance with this Act. Refer Public Works Act 1981, sections 52(1)(d), 52(3)

19 Summary and conclusion

This EIS provides a comprehensive outline of the key environmental features and values likely to be affected by such a project, together with an assessment of the significance of those effects based on the information available at the time of reporting.

Within that context, the key findings of this EIS are:

Inundation of Lake Onslow

The project requires the inundation of up to 7100 hectares (ha) of land and a number of streams and rivers to create an enlarged Lake Onslow.[386]

Approximately 6550ha of that inundated land is held in the private ownership of ten landowners, as well as by two power companies and the Central Otago District Council.

Up to 46ha of inundated land is conservation (stewardship) land in the southeast portion of the Manorburn Conservation Area. The balance of the conservation land is marginal strips.

Much of the inundated land (and existing streams and rivers) contains high to very high mana whenua, ecological, conservation and archaeological values.

The creation of the enlarged Lake Onslow is therefore expected to result in:

- The loss of up to approximately 1330ha of important wetland ecosystems including:
  - The loss of 526ha of the Fortification Creek wetland complex which is considered to be nationally significant based on its size, intactness and diversity of plant species. It is also identified as an area of Significant Natural Value for its indigenous biodiversity characteristics.
  - The loss of 94ha of the Boundary Creek Fen, which is regionally significant based on its high degree of naturalness.
  - The loss of 65ha of Middle Creek wetland, which is also regionally significant based on its high degree of naturalness.
- The loss of and/or disruption to habitats of Threatened plant and animal species. Specifically:
  - Nationally Threatened or At Risk species of fish and lizard, including:
    - Threatened-Nationally Critical: Teviot flathead galaxias
    - Threatened-Nationally Endangered: Burgan skink, dusky galaxias
    - At Risk-Declining: southern grass skink, Otago green skink, korero gecko.
  - Nationally Threatened plant species:
    - Threatened-Nationally Critical: kettlehole cudweed *Pseudognaphalium ephemerum*, turf cress *Cardamine mutabilis*, saltgrass *Puccinellia raroflorens*, salt-pan cress *Lepidium kirkii*, *Simplicia laxa*

386 Based on the project description provided to the environmental specialists in May 2022. As at the design freeze in July 2022, this number is now 7000ha

    - Threatened-Nationally Endangered: *Hypericum rubicundulum*, *Chaerophyllum colensoi var. delicatulum*, *Crassula multicaulis*, dryland cress *Pachycladon cheesemanii*
    - Threatened-Nationally Vulnerable: New Zealand mousetail *Myosurus minimus* subsp*. novae-zelandiae*, climbing broom *Carmichaelia kirkii*, Grassy mat sedge *Carex inopinata*, *Ranunculus ternatifolius*, *Sonchus novae-zelandiae.*
  - Nationally Threatened or At Risk bird species:
    - Threatened-Nationally Endangered: black fronted tern *Chlidonias albostriatus*
    - Threatened-Nationally Vulnerable and Taoka species in the Ngai Tahu Claims Settlement Act 1998: Paarere - grey duck *Anas superciliosa*, kaarearea-eastern falcon *Falco novaeseelandiae*, kaamana-southern crested grebe *Podiceps cristatus australis*
    - At Risk-Declining: black-billed gull *Chroicocephalus bulleri*, banded dotterel *Charadrius bicinctus*, New Zealand pipit *Anthus novaeseelandiae*, South Island pied oystercatcher *Haematopus finschi.*
- The loss of approximately 99.5% of the trout spawning habitat in the tributaries to Lake Onslow with a subsequent reduction in trout productivity leading to a significant adverse effect on the population of brown trout and on Lake Onslow as a recreational angling resource.
- The loss of eight recorded archaeological sites within the proposed inundation area, including one assessed as having 'high' significance and five as having 'medium' significance with a further six recorded archaeological sites within 1km of the inundation area likely to also be adversely impacted. Other archaeological sites and heritage features may also be impacted depending on final design.

Lake Onslow water level fluctuation

The operation of the Lake as a hydro battery will result in significant fluctuations in lake levels.

Those fluctuations will result in:

- A very high adverse impact on the landscape character of the East Otago Uplands (which includes a Landscape Management Area and part of an Outstanding Natural Landscape)
- A significant adverse effect on the use of lake as a recreational angling destination
- Significant adverse effects on other recreational activities such as cycling and walking
- The loss of submerged plant species from the Lake.

Wetland ecosystems and other habitats will not re-establish around the new Lake margins because of the fluctuations in lake levels.

Lake Onslow dam structure

The project will require the development of a dam structure and associated infrastructure.

That dam structure and associated infrastructure will:

- Require the diversion of Te Awa Makarara/Teviot River during construction (approximately 4–5 years)
- Result in a very high adverse impact on the natural character of the East Otago Uplands (which includes a Landscape Management Area and part of an Outstanding Natural Landscape).

Lower reservoir: offtake and intakes

The project will require the development of offtake and intake infrastructure at either s 9(2)(i) [redacted]

s 9(2)(i) [redacted] The infrastructure for the offtake option would result in:

- The loss of a significant area of the plant species makahikātoa (Threatened-Nationally Vulnerable)
- Direct impacts on, including potential acquisition of, privately owned land, as well as land owned by the Crown and the Central Otago District Council.

If s 9(2)(i) [redacted] is selected as the preferred offtake option, that infrastructure would result in:

- The loss of four recorded archaeological sites
- The loss of habitat for Threatened lizard species
- The loss of Land Use Capability (LUC) 3 soils which may be considered to be 'highly productive'
- Direct impacts on, including potential acquisition of, privately owned land, as well as land owned by the Crown and the Central Otago District Council.

If s 9(2)(i) [redacted] is selected as the preferred offtake option, that infrastructure would result in:

- The loss of four recorded archaeological sites
- The loss of habitat for Threatened lizard species
- The loss of LUC 3 soils which may be considered to be 'highly productive'
- Direct impacts on, including potential acquisition of, privately owned land, as well as land owned by the Crown and the Central Otago District Council.

Project outflows below the Roxburgh Dam

If the project utilises an outflow below the Roxburgh Dam, the operation of the project will result in greater variability of river flows in the lower Mata-Au/Clutha River below the selected abstraction/discharge location.

This may result in adverse impacts on water quality and aquatic ecology of the lower Mata-Au/Clutha River.

This will result in adverse impacts on river use including angling, white water activities and the operation of the Tuapeka Mouth Ferry.

Overall, these findings indicate that while the project may deliver significant and highly valuable benefits to the people and communities of Aotearoa New Zealand, those benefits will come at the cost of important wetlands, fish and plant species which are unlikely to be replaceable.

Specifically, the unavoidable loss of regionally and nationally significant, extensive, diverse, and rare wetlands is one of the most significant adverse effects of the project, which will require a focus on protecting and enhancing other similar wetlands in the local landscape, and, critically, accepting a net loss of wetland extent nationally. This is inconsistent with national policy direction on the retention of remnant wetlands.

As a result of the necessary inundation of land and waterways and the significant loss of habitat, several species of Threatened or At Risk plants and animals will be adversely impacted.

Potential management of these effects on freshwater values includes a range of remediation and offsetting actions. The design and operating regime of the project will be crucial in the management of effects.

The expected impacts on the natural and physical resources and habitats of the area are highly significant to mana whenua, with much of the project area holding important cultural values related to waterbodies, wetlands, indigenous freshwater and terrestrial species and habitats as well as various wāhi tupuna (*ancestral landscapes*), ara tawhito (*traditional travel routes*) and sites of archaeological significance. In particular, wai (*water*) is considered to be a taoka (*treasure*) of 'extreme significance' to Kāi Tahu with the mauri of water acting as a life-giving force, connecting the environment from the mountains to the sea.

In a similar vein, while impacts on natural resources will be widespread and, in some cases, unavoidable and irreversible, significant social disruption is also an anticipated consequence of the project, particularly for the most directly impacted landowners, as well as resulting in increased pressure on essential infrastructure, community services and recreational pursuits for the balance of the community. Such impacts may be offset by other benefits and gains to the relevant communities including increased employment opportunities, accommodation and services improvements.

While it is possible that further investigations may reveal additional significant environmental values and features which will be adversely affected by the construction and operation of the project it is unlikely that the effects already identified and outlined above will be eliminated or significantly reduced as a result of any such further work. As such, the scope of work completed to date (while necessarily limited) provides sufficient confidence that the nature and scale of the project is such that it will inevitably result in significant adverse effects on important environmental values. Given the size and scale of development necessary to deliver a project of this nature, that can be expected to be the case irrespective of the location chosen.

20 References

Aukaha (1997) Limited. (2021). *Cultural Values Statement: The Lake Onslow option for the New Zealand Battery Project*.

Aukaha (1997) Limited. (2022). *Cultural Values Statement: The Lake Onslow option for the New Zealand Battery project Phase 1B.*

Blakley Wallace Associates. (2021). *New Zealand Battery Project: Landscape and Visual Assessment*.

Blakely Wallace Associates. (2022). *Addendum Report, Specialist Report – Landscape*. NZ Battery Project: Lake Onslow PSS: Phase 1B Feasibility Study.

Boffa Miskell Limited (2006). *Tasman Lakes Estate Private Plan Change Request: Wildlife Survey / Kowhai Stream Mouth*. Report Prepared by Boffa Miskell Ltd for Pritchard Group Ltd. Report No. W06050-1_003.

Cawthron Institute. (2022). *Baseline Ecological Assessment of Lake Onslow and the Teviot River for the NZ Battery Project*.

Central Otago District Council. (2008). *Central Otago District Plan*

Contact Energy. (2022)*. Our powerstations.* https://contact.co.nz/aboutus/our-story/our-powerstations#:~:text=The%20Clyde%20Dam%20on%20Lake,its%20four%20turbine%20generator%20units.

Davidson-Watts Ecology. (2022). *Lake Onslow Area Bay Survey*.

Department of Conservation. (2005). *Conservation General Policy*.

Department of Conservation. (2016). *Otago Conservation Management Strategy*.

Department of Conservation. (2020). *Aotearoa New Zealand Biodiversity Strategy - Te Mana o Te Taiao.*

Department of Conservation. (2022). Survey Report - *Freshwater Fish Values (NZ Battery Project – Lake Onslow Option)*.

Department of Conservation. (2022). *NZ Battery Project – Lake Onslow Option: Assessment of Conservation Values at Lake Onslow*.

Department of Conservation. (2022). *Proposed infrastructure impacts to Teviot flathead galaxias habitats, Teviot River*.

Department of Conservation. (2022). *Paper: Translocation Proposal – Teviot flathead galaxias.*

Hawke's Bay Regional Investment Company Limited v Royal New Zealand Forest and Bird Protection Society of New Zealand Inc [2017] NZSC 106, [130] – [134].

International Institute for Sustainable Development. (2022). How and Why Lakes Stratify and Turn Owner: We explain the science behind the phenomena. www.iisd.org.nz

IPCC. (2006). *Intergovernmental Panel on Climate Change Method Guidelines for Greenhouse Gay Inventory*.

Kāi Tahu ki Otago. (2005). *Natural Resource Management Plan*

Land Air Water Aotearoa. (2022). *Air quality.* https://www.lawa.org.nz/explore-data/otago-region/air-quality.

Land Air Water Aotearoa. (2022). *Stream orders*. https://www.lawa.org.nz/.

Land Air Water Aotearoa. (2022). *Water quality*. https://www.lawa.org.nz/.

Leathwick, J R, F Morgan, G Wilson, D Rutledge, M McLeod, and K Johnston. 2002. *Land Environments of New Zealand: A Technical Guide*. Wellington: Landcare Research, Ministry for the Environment.

Lynn, I., Manderson, A., Page, M., Harmswoth, G., Eyles, G., Douglas, G., Mackay, A. and Newsome, P. (2009). *Land Use Capability Survey Handbook. A New Zealand Handbook for the Classification of Land.* 3rd edition.

Manaaki Whenua - Landcare Research. (2022). *NZ Land Atlas /Land Use Capability. https://ourenvironment.scinfo.org.nz/maps-and-tools/app/Land%20Capability/lri_luc_main.*

McEwen, M. (1987). *Ecological Regions and Districts of New Zealand*. NZ Biological Resources Centre, published by the Department of Conservation.

Ministry for the Environment and Stats NZ. (2020). *New Zealand's Environmental Reporting Services: Our freshwater 2020.*

Ministry for the Environment and the Ministry for Primary Industries. (2019). *Valuing highly Productive Land. A Discussion Document on a Proposed National Policy Statement for Highly Productive Land*. MPI Discussion Paper 2019/05.

New Zealand Government. (1987). *Conservation Act*

New Zealand Government. (2011). *National Policy Statement on Renewable Electricity Generation*.

New Zealand Government. (2014). *Heritage New Zealand Pouhere Toanga Act*.

New Zealand Government. (2019). *Draft National Policy Statement on Indigenous Biodiversity*.

New Zealand Government. (2020). *National Policy Statement for Freshwater Management*.

New Zealand Government. (2022). *Exposure draft on the National Policy Statement for Indigenous Biodiversity.*

New Zealand Greenhouse Gas Inventory. (2021). *National Inventory Report.*

New Zealand Heritage Properties Limited. (2022). *Lake Onslow Battery Intake Options, A Statement of Archaeological and Heritage Resources*.

New Zealand Heritage Properties Limited. (2022). *Lake Onslow Hydro Storage Project, A Desktop Assessment of Archaeology and Heritage.*

New Zealand Plant Conservation Network. (2022). *Pseudognaphalium ephemerum Fact Sheet*. *https://www.nzpcn.org.nz/flora/species/pseudognaphalium-ephemerum/.*

Nick Taylor and Associates. (2022) *Assessment of Social Impacts (Scoping)*.

Nick Taylor and Associates. (2022). *Aotearoa/NZ Battery Project – Interim assessment of social impacts for Lake Onslow pumped hydro scheme option*.

NIWA. (2010). *New Zealand Periphyton Guideline: Detecting, Monitoring and Managing Enrichment of Streams*.

NIWA. (2022). *Addendum to Lake Onslow baseline reports.*

NIWA. (2022). *Assessment of Lake Onslow Climate, Hydrology and Ecology*.

NIWA. (2022). *Hydrology, water quality and ecology of the lower Clutha*.

NIWA. (2022). *What are greenhouse gases? https://niwa.co.nz/atmosphere/faq/what-are-greenhouse-gases.*

Oceana Gold (New Zealand) Limited v Otago Regional Council [2019] NZENVC 41 at [93].

Otago Fish & Game Council. (2022). *An Investigation into Lake Onslow Brown Trout Spawning Habitat Availability at Increased Lake Heights*.

Otago Regional Council. (2004). *Regional Plan: Water for Otago*.

Otago Regional Council. (2018). *Our Living Treasure* | *Tō tātou Koiora Taoka, Otago Regional Council's Biodiversity Strategy.*

Otago Regional Council. (2009). *Regional Plan: Air for Otago.*

Otago Regional Council. (2018). *Air Quality Strategy for Otago.*

Otago Regional Council. (2019). *Otago Regional Policy Statement*.

Otago Regional Council. (2021). *Proposed Otago Regional Policy Statement*.

Otago Regional Council. (2021). *State of the Environment Groundwater Quality in Otago.*

Otago Regional Council. (2022). Hazardous Activities, Industries and Bore Search. *https://maps.orc.govt.nz/portal/apps/MapSeries/index.html?appid=052ba04547d74dc4bf070e8d97fd6819.*

Otago Regional Council. (2022). Maps. www.maps.orc.govt.nz/Otagoviewer, search on 8 July 2022.

Otago Regional Council. (2022). Otago Natural Hazards Portal. *https://maps.orc.govt.nz/portal/apps/MapSeries/index.html?appid=b24672e379394bb79a32c9977460d4c2.*

Rob Greenaway & Associates. (2021). *Lake Onslow – NZ Battery Project, Preliminary Recreation Values Assessment*.

Rob Greenaway & Associates. (2022). *Aotearoa New Zealand Battery Project. Recreation Values Assessment.*

Seebeck H, Van Dissen R, Litchfield N, Barnes P, Nicol A, Langridge R, Barrell DJA, Villamor P, Ellis S, Rattenbury M, Bannister S, Gerstenberger M, Ghisetti F, Sutherland R, Fraser J, Nodder S, Stirling M, Humphrey J, Bland K, Howell A, Mountjoy J, Moon V, Stahl T, Spinardi F, Townsend D, Clark K, Hamling I, Cox S, de Lange W, Wopereis P, Johnston M, Morgenstern R, Coffey G, Eccles JD, Little T, Fry B, Griffin J, Townend J, Mortimer N, Alcaraz S, Massiot C, Rowland J, Muirhead J, Upton P, Hirschberg H, Lee J. (2022). *New Zealand Community Fault Model* – version 1.0. Lower Hutt (NZ): GNS Science. 96 p. (GNS Science report; 2021/57).

Stirling, M. (2022). *Onslow Project Area: Deterministic Earthquake Hazard*, University of Otago, citing Meyer, AFT. (2021). *A paleoseismic investigation of the Long Valley Fault, Central Otago*. A thesis submitted for the degree of Bachelor of Science with Honours at the University of Otago, New Zealand.

Te Rōpū Matatau. (2021) *Geological, Geotechnical and Hydrogeological Data Report.* NZBLO-TRM-01A-10-RPT-GEO-000051-A.

Te Rōpū Matatau. (2022). *Consenting Strategy.* NZBLO-TRM-01A-010-RPT-CON-000430-C.

Te Rōpū Matatau. (2022). *Feasibility Study Report.* NZBLO-TRM-01B-010-RPT-MDP-000379-A

Te Rōpū Matatau. (2022). *Groundwater quality technical memorandum*. NZBLO-TRM-01B-010-TMN-GEO-000464-A.

Te Rōpū Matatau. (2022). *Hydrology and Hydrological Report*. NZBLO-TRM-01A-021-RPT-HYD-000186-A).

Townsend, A. J., P. J. de Lange, Clinton A. J. Duffy, Colin M. Miskelly, Janice Molloy, and David A. Norton. (2008). *New Zealand Threat Classification System Manual.* Wellington: Department of Conservation.

Upper Clutha Tracks Trust v Queenstown Lakes DC [2012] NZEnvC 43.

Viadero, R., Rehbein, M. and Singh, A. (2017). *Hydropower on the Mississippi River.*

Wildlands Consultants Limited. (2022). *Assessment of options to address the ecological effects of the proposed Lake Onslow pumped hydro scheme*.

Wildlands Consultants Limited. (2022). *Desktop Assessment of Vegetation and Botanical Values in the Vicinity of the Proposed Lake Onslow Pumped Hydro Storage Project, Otago.*

Wildlands Consultants Limited. (2022). *Evaluation of Freshwater Invertebrate Features and Values.*

Wildlands Consultants Limited. (2022). *Evaluation of Terrestrial Indigenous Biodiversity Features and Values at Lake Onslow and Adjacent Vegetation and Habitats, Central Otago.*

Wildlands Consultants Limited. (2022). *Lizard Species Present (or Potentially Present) in the Vicinity of the Lake Onslow Pumped Hydro Storage Project.*