Boffa Miskell

Manapōuri Lake Control Improvement Project

Wetland Assessment Report
Prepared for Meridian Energy Limited

15 December 2023

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Cover photograph: Waiau Arm, Lake Manapōuri directly upstream of the Manapōuri Lake Control Structure © Boffa Miskell, 2023

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Executive Summary

- The Waiau Arm channel conveys flow from the Lake Manapōuri to the Manapōuri Lake Control structure (MLC), where minimum flows, lake and flood flows, recreational flows and flushing flows are released to the Lower Waiau River downstream. Each of these flows assists with managing nuisance periphyton growth and has benefits for river health. However, the current channel depth and alignment, and gravel accumulation in the Waiau Arm immediately upstream of the MLC, have been identified as physical constraints affecting flow conveyance and reliability, particularly for flushing flows.
- The aim of the Manapōuri Lake Control Improvement Project is to reduce these constraints by constructing a new and deeper channel adjacent and parallel to the Waiau Arm and by removing accumulated gravel, and to provide for any necessary maintenance of the Waiau Arm channels. Following construction of the new and deeper channel, more reliable conveyance of consented flows into the Lower Waiau River (LWR) is expected.
- Meridian Energy engaged Boffa Miskell Limited to prepare an Ecological Impact Assessment (EcIA) to consider the effects of the construction and operation of a new and deeper channel adjacent and parallel to the Waiau Arm on wetlands and terrestrial vegetation.
- The scope of this report does not include assessing of the effects of the Project on aquatic ecology values of the Waiau Arm and the LWR, or freshwater birds. The actual and potential effects of the Project on these ecological values have been assessed in a separate technical report prepared by NIWA.
- Ecological investigations for this EcIA included desktop research to obtain relevant existing information, a helicopter survey of riparian wetlands downstream of the MLC, an initial on-the-ground survey of wetland areas within and near the Project site and a more detailed survey of all the wetlands in the vicinity of the proposed channel construction and spoil disposal areas.
- The assessment identified that:
    - The Project site has previously been extensively modified during the construction of the Manapōuri Power Scheme in the 1970s, including construction of the MLC.
    - The terrestrial vegetation within the proposed construction footprint of the parallel channel is exotic grassland and crack willow treeland of negligible ecological value and the terrestrial vegetation within the excavation channel and spoil disposal and contractor's establishment areas is exotic grassland and young planted Eucalyptus trees; also of negligible ecological value.
    - There are 12 small areas of palustrine marsh that support wetland vegetation in the vicinity of the spoil disposal and contractor's establishment areas. All these wetland areas are likely to be only infrequently wet, supported only weakly hydrophytic vegetation and were dominated by exotic plant species, although some supported indigenous wetland plant species. Nine wetland areas were of low ecological value and the remaining three were of low – moderate ecological value. Project shaping advice was provided to Meridian that recommended setting-back the proposed spoil disposal area and contractor's establishment areas from these wetlands by a minimum of 10 m to avoid effects on those features.

- Seven riparian wetlands were identified downstream of the Project site between MLC and the LWR confluence with the Monowai River (approximately 23 km downstream of MLC). One wetland was assessed as being of low ecological value and the remaining six were of moderate ecological value.
- Those areas of the Project site that meet the threshold for significance under the criteria in Appendix 3 of the SRPS are wetland and lake margin areas of the Project site that support the nationally At Risk – Declining plant Buchanan's sedge and potentially, the relatively less modified margins of the Waiau Arm that support indigenous macrophyte / mudfield communities.

- The actual and potential effects of the Project on wetlands and terrestrial vegetation include:
  - The removal of small (122 m^2), low value palustrine marsh (Wetland 1) which is within the proposed channel excavation footprint. In terms of the indigenous values present, these are solely the presence of the common and widespread fan-flowered rush. The level of effect of the removal of this wetland has been assessed as **Very Low**.
  - Potential effects to hydrophytic vegetation and wetland habitats in 'lacustrine channel' areas adjacent to the parallel channel and haul road arising from earthworks and vegetation clearance at the southern end of the channels; sedimentation and smothering of wetland / lacustrine vegetation, temporary loss of hydrological connection to Waiau Arm during construction due to construction of a haul road and bunds, and hydrological changes resulting from temporary de-watering and loss of surface water connection. The level of these effects on wetland vegetation and habitats has been assessed as **Low**. Use of best practice erosion and sediment control measures are recommended to minimise temporary sedimentation and smothering of vegetation and habitats in these 'lacustrine channel' areas.
  - The removal of <10 At Risk – Declining Buchanan's sedge plants, which has been assessed as having a **Low** level of effect. However, these plants are also an ecologically significant feature of the Project site so transplanting all affected plants to a suitable area of lacustrine habitat within the Project site, as well as follow-up monitoring of survival and replacement planting (if required), is recommended for this species.
  - Removal of vegetation to establish the spoil disposal area and contractor's establishment area. The vegetation within these areas is exotic grassland and recently planted *Eucalyptus* trees of Negligible ecological value. The level of effect has been assessed as **Very Low.**
  - Sediment and stormwater runoff to Wetlands 2-9 during initial topsoil stripping and vegetation removal, during formation of bunds and following spoil deposition. The level of these effects has been assessed as **Very Low - Low**. Implementation / installation of appropriate erosion and sediment control measures prior to initial topsoil stripping and vegetation removal and formation of bunds is recommended to avoid sediment discharge into these small wetlands.
  - Increased runoff of rainfall to Wetlands 2-9 from the final landform / slopes of the spoil disposal area potentially increasing water levels or prolonging inundation and / or soil saturation. This effect has been assessed as either having **No Effect** or possibly a slight **Net Gain**.
  - Hydrological changes to Wetlands 2-9 resulting from possible temporary partial dewatering of the parallel channel excavation. A temporary reduction in groundwater

levels associated with the proposed dewatering of the parallel channel excavation has been assessed as having a less than minor effect on the hydrology of these features and a **Very Low** level of ecological effect.

- Minor changes in flow in the LWR for the duration of the Project are expected to have a **Very Low** level of effect on downstream riparian wetlands of Low to Moderate ecological value.
- Sedimentation and smothering of wetland vegetation in downstream riparian wetlands has also been assessed as **Very Low**, primarily because construction works are proposed to be completed under generally low flow conditions, meaning fine sediment deposition is less likely to occur in riparian wetlands which are elevated above the normal river level. Project design, including avoiding working instream as much as possible and adherence to thresholds for, and monitoring of, SSC and DFS will also minimise this potential effect.
- Improved flushing flows may benefit downstream riparian wetlands by contributing to wetland recharge, excluding dryland weeds and increasing the range of habitat niches for wetland species. However, flushing flows may not be large enough to influence or inundate relatively higher elevation riparian wetlands, meaning that improved flow conveyance may actually have no effect.

- Overall, the level of effect of the construction and operation of the Project on wetlands and terrestrial vegetation, with implementation of project shaping and other impact management recommendations, is generally expected to be Very Low to Low.

1.0 Introduction

1.1 Purpose of the Project

Meridian Energy Limited (Meridian) releases flows through the Manapōuri Lake Control Structure (MLC) to the Lower Waiau River (LWR) in accordance with existing resource consent conditions. The types of flow released include minimum flows, lake and flood flows, recreational flows and flushing flows. Each of these assists with managing nuisance periphyton growth and has benefits for river health. However, the current channel depth and alignment, and gravel accumulation in the Waiau Arm immediately upstream of the MLC, have been identified as the primary physical constraints affecting flow conveyance and reliability, particularly for flushing flows. The aim of this Project is to reduce these constraints by constructing a new and deeper channel adjacent and parallel to the Waiau Arm and by removing accumulated gravel, and to provide for any necessary maintenance of the Waiau Arm channels. Following construction of the new and deeper channel, more reliable conveyance of consented flows into the LWR is expected.

1.2 Background

1.2.1 Context

Meridian owns and operates the Manapōuri Power Scheme (MPS), the largest single hydroelectric scheme in the country. Water in Lake Manapōuri is used to generate electricity at the underground station at West Arm. The MPS is operated under the Operating Guidelines for Lakes Manapōuri and Te Anau (the Guidelines) which was set in place under the Manapōuri – Te Anau Development Act 1963 (MTADA) and gazetted on 21 November 2002.

The catchment area for the MPS includes Lakes Manapōuri and Te Anau, and water that is diverted into Lake Manapōuri from the Mararoa River catchment at the Manapōuri Lake Control Structure (MLC). Meridian holds a suite of resource consents for water takes, diversions, discharges and maintenance associated with the MPS and the MLC.

The MLC is located southeast of Lake Manapouri, at the confluence of the Waiau and Mararoa Rivers, forming the downstream control of the outlet of Lake Manapōuri. The MLC is a key component of the MPS, essential to the operation and management of the scheme. It assists by controlling and managing the level of Lake Manapōuri, diverting water from the Mararoa River into Lake Manapōuri for hydro-electric generation, and controlling the discharge of water to the LWR catchment, including for minimum flow, lake and flood spill, recreational and flushing flow purposes. Investigations have confirmed the Waiau Arm channel at the MLC does not currently have the flow conveyance capacity to reliably pass in particular flushing flows to the LWR. This is due primarily to the depth of the channel approximately 900 metres upstream of the MLC. Hydraulic modelling undertaken by Damwatch in 2022 indicates that deepening the Waiau Arm channel reach and constructing a new channel parallel to the current Waiau Arm channel would allow for more reliable flow conveyance and delivery, and in particular, for flushing flows over a wider range of lake conditions.

1.2.2 Trial excavations

The potential for sediment generation from the Project works was recognised early in the development of the construction methodology. To inform the option selection process, Meridian undertook a series of trial excavations in February 2023. The purpose of the trials was to:

- Assess the ability to excavate the riverbed material from a bund platform to target excavation depths;
- Quantify the level of likely suspended sediment, deposited sediment and increase in turbidity resulting from the work; and
- Better understand the nature and characterisation of channel substrate material within the proposed excavation footprint.

The trials involved the construction of bunds and the excavation of bed material along an approximately 900 m stretch of the Waiau Arm. NIWA were engaged by Meridian to quantify the suspended sediment generated from the trial works by recording data at Duncraigen Bridge, approximately 375 m downstream of the MLC gates.

The trials concluded the following:

- The riverbed material is sufficient to support the excavator machinery proposed for the Project;
- Monitoring showed that bund construction and removal, and excavation of bed material, causes rapid increases in suspended sediment concentration (SSC) and decreases in visual clarity (VC). The trial appeared to cause little increase in deposited fine sediment (DFS), but confounding issues during the trial meant that this result was inconclusive; and
- River substrate was highly variable across the site, ranging from sandy gravels to silts and clays.

Further details of the trial excavations are contained in the AEE.

1.2.3 Option selection process

The selection of the parallel channel methodology has been subject to an extensive assessment and multi-criteria analysis involving multiple technical specialists. The trial investigations undertaken established that a predominantly instream excavation had a high likelihood of suspended sediment generation and discharge into the LWR. For this reason, options involving excavation over several months within the wet area of the Waiau Arm were not progressed further. The proposed parallel channel occurs substantially offline or outside of the wetted area of the Waiau Arm. As such, it has been assessed as the least effects option for releasing suspended and deposited sediment to the LWR during the excavation works, while appropriately managing all other environmental effects.

Details of the option selection process are addressed in the AEE, but by way of summary:

- Instream options of deepening of the existing Waiau Arm, using a range of different methodologies and techniques (including excavators working from constructed bunds), was discounted due to the potential high levels of rapid sediment generation over long periods for instream works, which are difficult to practically manage;

- Cutter suction dredging was discounted due to the range of bed materials found in the LWR being unsuitable for this methodology and mobilisation of plant and facilities was considered to be more complex;
- Dragline excavation was ruled out due to limited operators and equipment available;
- Excavation from barges was ruled out due to the relatively confined work area and potential safety issues, complex set up and ability to be dismantled if flooding were forecast; and
- Temporary damming structures were ruled out due to constructability and potential safety issues.

1.3 Purpose and Scope of this Report

This purpose and scope of this report is to assess the effects of the construction and operation of Meridian's proposed parallel channel on terrestrial vegetation and wetlands including:

- Wetlands (as defined under the Resource Management Act (RMA) and National Policy Statement – Freshwater Management 2020 (NPS-FM).
- Terrestrial and lacustrine (lake edge) vegetation and habitats within the Project site, including within the construction footprint of the parallel channel and the lacustrine 'channels' on the northern bank of the Waiau Arm that are within the lake bed[1]. The hydrophytic vegetation associated with the three lacustrine 'channels' occur on areas that are below the maximum permitted operating level of Lake Manapōuri. These areas are considered part of the bed of the lake and are not considered to be 'wetlands' and therefore, are also not considered to be 'natural inland wetlands'. However, this report has assessed the wetland vegetation of these areas for completeness and reached conclusions as to effects on these values.
- Riparian wetlands downstream of the MLC (i.e. associated with the LWR).

The scope of this report does not include assessing of the effects of the Project on:

- Aquatic ecology values of Waiau Arm and the LWR including benthic plant communities (macrophytes), periphyton (benthic algae), phytoplankton, macro-invertebrates and freshwater fish; and
- Freshwater birds;

The actual and potential effects of the Project on these ecological values have been assessed by NIWA (2023).

[1] Under the RMA, in relation to *any lake controlled by artificial means*, bed means *the space of land which the waters of the lake cover at its maximum permitted operating level*, which, for Lake Manapōuri, means land below 180.5 m a.s.l. / 180.36 NZVD 2016.

1.4 Report Structure

This report:

- Describes the project (Section 2.0);
- Outlines the methods used to undertake the site investigations and assessment (Section 3.0);
- Describes the existing ecological environment, as it relates to wetlands[2], and assesses the ecological value of those wetlands (Section 4.0);
- Describes the project shaping process (Section 5.0);
- Assesses the ecological effects of the Project on wetlands (Section 6.0);
- Provides recommendations for managing effects on wetlands (Section 7.0); and
- Provides a summary and conclusions (Section 8.0).

2.0 Description of the Project

2.1 Site location

The MLC is located approximately 9 km south-east of Lake Manapōuri and the Manapōuri township, at the confluence of the Waiau and Mararoa Rivers. The Project site is bound by the Waiau Arm and farmland to the north and west, the LWR and farmland to the south, and the Mararoa River to the east. A plan showing the location of the Project site is provided in Figure 1. Full details of the Project site are contained in the AEE.

2.2 Overview

The Project will involve the construction of a new channel which is parallel to, and largely offline from the current bed and channel of the Waiau Arm. Approximately 225,000 m^3 of gravel and bed material will be excavated and disposed of on Meridian owned land near the new channel.

Subject to obtaining resource consents, and hydrological conditions, Meridian proposes to undertake the works within a 10-month window of January to October 2025. The overall construction period within this window is envisaged to be approximately 4 – 5 months. The up and downstream cuts to connect the parallel channel to the current bed and channel requiring works in water is anticipated to take approximately 5 weeks if undertaken simultaneously. The remainder of the construction window is required for establishment, disestablishment, and rehabilitation activities. Works are proposed to occur on a 7-days per week and up to 24 hours per day basis.

The bulk channel excavation works are targeted to the time of year when hydrological conditions are likely most favourable for safe and efficient delivery of the work. The construction window has

[2] That are within the scope of the assessment (refer to Section 1.3).

also been identified to limit disruption to Meridian's monitoring requirements under existing resource consent conditions.

A more comprehensive description of the Project, and the proposed methodology, is included in the AEE, and the construction methodology report prepared by Damwatch Engineering Ltd. (Damwatch 2023).

2.3 Spoil Disposal and Contractor's Establishment Area

2.3.1 Spoil Disposal Area

Spoil from the channel excavation will be placed in a designated 'spoil disposal area'. The spoil disposal area is a relatively flat area of exotic grassland and young planted *Eucalyptus sp.* trees (described in more detail in Section 4.0) on the former Mararoa River Delta north of the channel construction footprint (and Waiau Arm) and west of the Mararoa River (Figure 1).

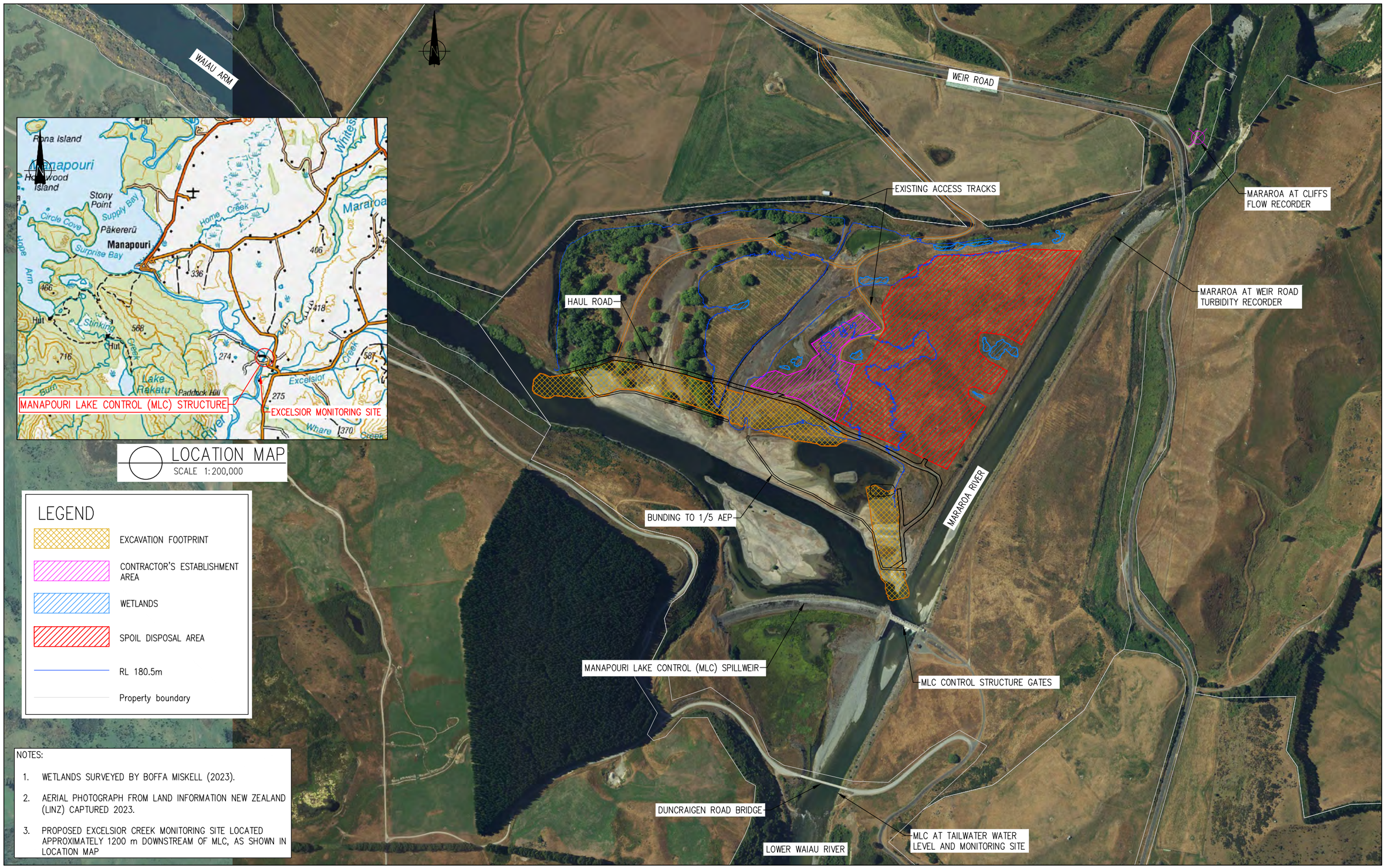
To prepare the spoil area, vegetation and topsoil will be stripped, with topsoil stockpiled as perimeter silt control bunds of approximately 3.0 m in height for later reinstatement over the area. The bunds will retain dirty water running off the spoil when placed, which is expected to soak into the permeable gravel subgrade. With a total area of approximately 120,000 m² and a total channel excavation volume of 225,000 m³ the spoil area will be filled to an average of 1.9 m. Spoil will be filled in layers of approximately 0.3 m, spread and compacted by bulldozer and grader.

A portion of the spoil area has been set aside as a stockpile area, where gravels will be selectively placed, for potential future reuse. The stockpile area has a capacity for approximately 100,000 m³ of compacted spoil.

The spoil area will be contoured with minimum surface gradients of 2% draining toward the perimeter, to encourage surficial runoff of rainfall. At completion, the perimeter bunds will be trimmed to a gradient of 10%, with recovered topsoil material spread for surface rehabilitation.

2.3.2 Contractor's Establishment Area

An area of approximately 20,000 m² immediately north of the excavation footprint and west of the spoil disposal area will be used for the Contractor's Establishment Area. The area is relatively flat and includes the flat area that was historically used for gravel stockpiling. This area will contain the contractor's temporary facilities including offices, lunchrooms, portable ablutions, storage for fuel, oil and other substances. In addition, the area will include space for parking and refuelling of plant. Setup activities within the Contractor's Establishment Area include clearing vegetation and identifying and / or constructing flat areas above potential flood levels to locate facilities.



LOCATION MAP
SCALE 1:200,000

LEGEND

- EXCAVATION FOOTPRINT
- CONTRACTOR'S ESTABLISHMENT AREA
- WETLANDS
- SPOIL DISPOSAL AREA
- RL 180.5m
- Property boundary

NOTES:

1. WETLANDS SURVEYED BY BOFFA MISKELL (2023).
2. AERIAL PHOTOGRAPH FROM LAND INFORMATION NEW ZEALAND (LINZ) CAPTURED 2023.
3. PROPOSED EXCELSIOR CREEK MONITORING SITE LOCATED APPROXIMATELY 1200 m DOWNSTREAM OF MLC, AS SHOWN IN LOCATION MAP

A3 SCALE 1:7500
0 0.1 0.2 0.3 0.4 (km)

DRAWING STATUS: NOT FOR CONSTRUCTION

ISSUE	AMENDMENT	BY	CH'D	COMPANY	PROJECT	APP'D	DATE
A	ISSUED FOR INFORMATION	JA	DC	DAMWATCH	E2243	DCE	07/23
B	ISSUED FOR INFORMATION	JA	DC	DAMWATCH	E2243	DCE	10/23

Meridian.

MANAPOURI LAKE CONTROL

WAIAU ARM CHANNEL EXCAVATION
CONCEPT DESIGN
LOCATION PLAN

FOLDER: | DISTRIBUTION: B
DRAWING:
COMPANY: DAMWATCH
NUMBER: E2243–101 | ISSUE: B

2.4 Flow Management

During the Project, exclusive of site establishment and dis-establishment, it is proposed that the MLC gates will be operated to minimise flow in the Waiau Arm during the works and avoid flows toward Lake Manapōuri. The MLC gates will be opened to discharge the Mararoa River inflow down the LWR plus a margin, ensuring that any suspended sediment generated by the works will not travel up the Waiau Arm toward Lake Manapōuri during the excavation period. Positive flows (i.e., flows to the LWR from Lake Manapouri via MLC as opposed to no flow in either direction) will occur in the following circumstances:

- When flow from the Mararoa River is insufficient to provide minimum flows in the LWR (i.e., 12 m^3/s from May to September, 14 m^3/s in October and April, and 16 m^3/s from November to March);
- To provide monthly recreational flows in the LWR (approximately 35 m^3/s for 24 hours on the last Sunday of the month from October to April);
- To provide for the release of flushing flows[3] for the management of nuisance periphyton in the LWR. Flushing flows generally average at least 120 m^3/s over 24 hours and reach a peak flow of around 160 m^3/s (NIWA 2023).
- When Lake Manapōuri is above 187.6 m a.s.l. and flood rules will apply. At high lake levels rising above maximum control level, Waiau Arm discharge will be high and increasing, and conditions will likely be unsuitable for the excavation works.

Flushing flows or dilution flows can be used as a mitigation tool to reduce levels of suspended or deposited fine sediment during the Project. However, the ability to do this will be limited to a degree by lake levels.

2.5 Project Design to Reduce or Manage Sediment

As part of the Project, some sediment management measures have been incorporated into the design of the project (rather than recommended for effects management) including within the construction footprint, during instream works and for the spoil disposal area.

The main instream fine sediment release management method is the excavation methodology itself. The parallel channel avoids working instream as much as possible (approximately 85% of the excavation (by volume) will be completed remote from the Waiau Arm, behind bunds built up on the left riverbank) and minimises the period over which fine sediment may be generated.

In addition to this, during establishment of the spoil disposal area the Project design includes stockpiling topsoil to form perimeter silt control bunds of approximately 3.0 m in height above the existing ground. The purpose of the bunds will be to retain dirty water running off the spoil when placed, which will soak into the permeable gravel subgrade.

[3] The current protocol for monitoring and management of nuisance periphyton in the LWR provides for the release of up to four flushing flows in each season (between November and May) in response to “Red status” (i.e., high periphyton cover as quantified in instream surveys) (NIWA 2023). Flushing flows will be dependent on whether there is flow conveyance capacity to pass these flows.

2.6 Site Rehabilitation

Following completion of the channel excavation the Project site will be rehabilitated. Rehabilitation activities will include:

- Removal of temporary bunding by spreading on riverbank flats;
- Contouring of spoil areas to allow runoff to be appropriately directed;
- Replacement of topsoil cover on spoil areas; and
- Re-grassing or planting of spoil areas.

As part of rehabilitating the resultant spoil area, a defined ‘gravel stockpile cell’ of approximately 3.5 ha is proposed to provide an ongoing source of extracted gravel material made available to local contractors in response to demand. Rehabilitation in this area shall ensure:

- Gravel extraction is confined within the defined ‘gravel stockpile cell’ and operates sequential ‘bands’ from south to north enabling work to be progressively rehabilitated.
- Once gravel is extracted, the resultant surface will be scarified and sown in exotic pasture species to much the surroundings.

3.0 Methods

3.1 Desktop Review and Information Gathering

A desktop review was undertaken to gather information on the wetlands and terrestrial vegetation within and adjacent to the Project site and in the LWR downstream of the MLC.

An inventory of wetlands downstream of the MLC was undertaken by BML for the MTAD application (Boffa Miskell 2009). As part of this inventory the wetlands potentially influenced by the MPS were mapped in GIS. This information was the primary desktop data source used for reviewing downstream wetlands in the LWR.

Other imagery GIS (Geographic Information System) databases and spatial layers used to identify wetlands potentially affected by the Project were:

- Recent aerial imagery, including Google Earth;
- Environment Southland’s publicly available Southland Regionally Significant Wetlands and Water Bodies layer;
- The current and historic wetland layers from Freshwater Environments of New Zealand (FENZ; Ausseil et al. 2008); and
- Topographical (Topo50) data (Land Information New Zealand).

3.2 Site Investigations

Information to inform this assessment was collected during the following three site investigations:

1. A helicopter survey of wetlands downstream of the MLC on 26-27 August 2020;
2. An initial on-the-ground survey of wetland areas within and near the Project site on 28 February and 1 March 2022; and
3. A survey of all of the wetlands in the vicinity of the proposed channel construction and spoil disposal area on 19 - 21 December 2022.

The methods used during each of these surveys is described in more detail below.

3.2.1 Helicopter Survey of Wetlands Downstream of the MLC (August 2020)

Scott Hooson and Jaz Morris (Ecologists, Boffa Miskell) conducted a helicopter survey of wetlands associated with the LWR downstream of MLC on 26 - 27 August 2020 that, based on previous desktop analysis, were determined to be:

- Likely influenced hydrologically by the LWR; and
- Occurring substantially or wholly on land held by the Crown (including DOC)[4], Waiau Fisheries and Wildlife Habitat Enhancement Trust, Southland District Council (SDC), or Meridian.

During the helicopter survey:

- An iPad pre-loaded with wetland GIS information (locations and mapped wetland boundaries / extents) was used in conjunction with real time GPS location information in order to navigate in the air to wetlands;
- Where possible, flights around the entire wetland extent and the immediate surrounds occurred, with generally around 5 minutes spent at each wetland. No landings occurred at any wetland.
- Based on these observations, the accuracy of wetland boundaries (that had previously been mapped during a desktop exercise); was assessed, and, if necessary, a printed map of these approximate wetland boundaries was amended;
- A booklet containing the desktop information obtained for each wetland was referred to in the air, and information was confirmed, amended, or deleted, based on what could be seen; and
- Photographs of each wetland were taken from a range of elevations and aspects.

[4] In much of the LWR, particularly near Tuatapere, grazing concessions are held over Public Conservation Land (PCL) vested under DOC as Stewardship Land. Readily available cadastral information does not identify where such concessions are held, and thus overflights of some wetlands on PCL occurred based on an in-the-air assessment of whether or not any stock in the area were likely to be disturbed by helicopter activity.

3.2.2 Initial Wetland Survey (February / March 2022)

Scott Hooson visited the Project site on 28 February and 1 March 2022 and surveyed areas of wetland vegetation within the three lacustrine 'channels' on the northern bank of the Waiau Arm that are within the bed of Lake Manapōuri[5]. During the site visit:

- The areas with wetland vegetation were classified by hydrosystem, landform, wetland class and vegetation structural class following the wetland classification system of Johnson and Gerbeaux (2004)[6].
- Wetland plant communities were classified and recorded using the classification system and naming conventions developed by Atkinson (1985) and mapped on a laminated hard copy map.
- Temporary 2x2 m bounded wetland vegetation plots were measured following the wetland delineation procedure in the Wetland Delineation Protocols (Ministry for the Environment 2020[7]).
- The extent of each area was delineated by walking the wetland boundary and marking it using a handheld Garmin Global Positioning System (GPS) and a hard copy map.
- A walk-through survey was completed, and plant species and their cover (using the DAFOR scale) within each wetland plant community were recorded[8].
- General notes were made on the structure and condition of the vegetation communities and habitats present.
- Notes were made on the hydrology of each wetland and wetland hydrology indicators (Ministry for the Environment 2021a).
- A five-minute bird count was completed prior to commencing the assessment at each wetland and incidental observations of birds using the wetland were recorded throughout the site visit.
- Photographs were taken.

3.2.3 Channel Excavation and Spoil Disposal Area Wetland Delineation Survey (December 2022)

Field investigations including detailed vegetation survey were used to determine whether areas within the proposed channel excavation and spoil deposition works area of the Project site contain 'natural inland wetlands'[9]. The field investigations were undertaken on 19 - 21 December 2022 by Jaz Morris and Jess Schofield (Ecologists, Boffa Miskell).

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[5] The hydrophytic vegetation associated with the three lacustrine 'channels' occur on areas that are below the maximum permitted operating level of Lake Manapōuri. These areas are considered part of the bed of the lake[5] and are not considered to be 'wetlands' and therefore, are also not considered to be 'natural inland wetlands'.

[6] This wetland classification system has been developed for New Zealand and provides for the description of wetlands in a nationally consistent manner.

[7] These protocols were updated by Ministry for the Environment later in 2022, but only the 2020 version was available to be used during these surveys.

[8] Lists of the plant species recorded are provided in Appendix 1.

[9] As defined in the National Policy Statement for Freshwater Management 2020 (Amended February 2023).

Approximately 15 hours in total was spent on site during fine and mild to warm weather conditions. During the site visit:

- A walk-through survey was completed, and an overall plant species list for the site was recorded (see Appendix 1)[10].
  - The walk-through survey involved traversing the proposed channel excavation and spoil deposition works area in transects spaced c.30-50 m apart (see Figure 2).
  - The walkover generally excluded areas below the maximum permitted Lake Manapōuri operating level (i.e., that are river or lake bed) except where those areas occur within the spoil disposal area.
  - General notes were made on the structure and condition of the vegetation communities and habitats present.
  - Locations of possible wetland areas were recorded by handheld GPS.
  - Possible wetland areas were determined based on the presence and abundance of hydrophytic plant species (i.e., plants classified as Obligate / OBL or Facultative Wetland / FACW species; Landcare Research 2021).
- Following the walkover, possible wetland areas were revisited for detailed survey. At each location:
  - Temporary 2x2 m bounded wetland vegetation plots were measured in both wetlands following the wetland delineation procedure in the Wetland Delineation Protocols (Ministry for the Environment 2020).
    - Plots were placed in the area that appeared to contain the most strongly hydrophytic vegetation (i.e., the area most likely to pass the delineation test).
    - Within the plot, all plant species and their cover were recorded on a laptop pre-populated with a spreadsheet that automatically determined the results of the 'rapid' test, 'dominance' test, and 'prevalence index' test for hydrophytic vegetation.
    - Where required (e.g., based on ambiguous 'prevalence index' scores), indicators of wetland hydrology and the presence of hydric soils were assessed by visual means, including soil profiles. Because the entire site is a modified former riverbed that was fully worked over during construction of MLC and has recently (2021-2022) been further altered by being worked over for tree planting, natural soil profiles were found to be generally absent, but indicators of hydric soils were found in some locations. In the case of doubt (inconclusive results across all determinative tests) an area was inclusively treated as being a wetland.
    - Where an area was found to be wetland, additional plots along a representative transect at 5 or 10 m spacings were recorded as required to determine the wetland boundary.
  - Following the completion of a representative transect and assessment of the delineation test results along the transect, the boundary of each confirmed wetland area was mapped using handheld GPS.

[10] Lists of the plant species recorded are provided in Appendix 1.

- Notes were made on the hydrology of each wetland and wetland hydrology indicators (Ministry for the Environment 2021a).
- The wetlands were classified by hydrosystem, landform, wetland class and vegetation structural class following the wetland classification system of Johnson and Gerbeaux (2004).
- Wetland plant communities within each wetland were classified and recorded using the classification system and naming conventions developed by Atkinson (1985) and mapped on a laminated hard copy map.

- Incidental observations of birds using the wetland and surrounds were recorded throughout the site visit.
- Photographs were taken.

3.3 Assessing Ecological Value and Ecological Effects

To determine the level of ecological effects associated with the proposal, we have followed the Environmental Institute of Australia and New Zealand's (EIANZ) Ecological Impact Assessment (EcIA) Guidelines (Roper-Lindsay et al. 2018). In summary, the EcIA method requires assessments of:

- The values of communities, habitats / ecosystems and species (Table A2.1, Table A2.2 and Table A2.3, Appendix 2);
- The magnitude of impact (Table A2.4); and
- The level of ecological effect based on ecological value and magnitude of impact (Table A2.5).

3.1 Assessing Ecological Significance

Section 6(c) of the RMA requires identification of sites of significant vegetation and significant habitats of indigenous fauna.

The significance of terrestrial vegetation and habitats, including wetlands, was assessed against the criteria for determining significant indigenous vegetation and significant habitats of indigenous biodiversity listed in Appendix 3 of the Southland Regional Policy Statement (SRPS, Environment Southland 2017). Following Appendix 3 of the SRPS, areas or habitats are significant if they meet one or more of the criteria.

3.2 Other

Where possible, common names for plants and animals have been used in this report. Where a species does not have a common name, or its common name cannot be used to identify the species without ambiguity, scientific names have been used.

The conservation status of nationally Threatened and At-Risk indigenous species used in this report are from the most current versions of their respective New Zealand Threat Classification System (conservation status) lists[11].

3.3 Limitations

The following limitations and assumptions apply to this ecological impact assessment:

- Our assessment of the effects of the Project are based on the plans and project description provided in Damwatch (2023). Damwatch note that the methodology described in their report is not a finalised detailed design, and it is expected that modifications to this concept will be made by the construction contractor to best suit its available equipment and expertise, and the conditions encountered. The conceptual design is intended to convey an 'envelope' of expected work conditions, from which potential construction effects can be assessed.
- Our assessment of the effects of the Project on wetland's downstream of the Project site rely upon the information and analysis provided in NIWA's (2023) report, and in particular, Sections 3.6 – 3.8 ('Proposed Sediment Thresholds: Principles and derivation', 'Monitoring sediment thresholds', 'Mitigation Flows') and Sections 6.1 'Hydrology / flow variability' and 6.2 (Suspended and deposited fine sediment).

[11] https://nztcs.org.nz/

File Ref: BM220277_101_A3L_Figure_Survey_and_Vegetation_Plot_Locations.mxd

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Data Sources:
Land Information New Zealand, Damwatch Ltd.

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Cadastre
- Survey Track- Dec 2022

Wetland Delineation Plots:

- Pass - Wetland
- Fail - Not Wetland

MANAPOURI LAKE CONTROL IMPROVEMENT PROJECT

December 2022 Wetland Survey Route and Plot Locations

Date: 10 January 2023 | Revision: 1

Plan prepared for Meridian Energy by Boffa Miskell Limited

Project Manager: scott.hooson@boffamiskell.co.nz | Drawn: JMo | Checked: MDa

Figure 2

4.0 Existing Environment

4.1 Site Description

The Project site is bound by the Waiau Arm and farmland to the north and west, the LWR and farmland to the south, and the Mararoa River to the east. The project site is within the Upukerora Ecological District (ED, McEwen 1987). As described by McEwen (1987), extensive areas of the ED are now grazed farmland. The remaining indigenous vegetation of the ED includes beech forest, tall tussocklands, manuka scrub, and indigenous shrublands. Wetlands are common (especially in the west and southwest) with extensive raised peat bog wetlands an important feature of the area.

The proposed channel excavation works will primarily occur adjacent to, and on, the northern bank of the existing channel of the Waiau Arm. Spoil from the channel excavation will be placed on a relatively flat area of exotic grassland and young planted *Eucalyptus* sp. trees on the former Mararoa River Delta north of the channel construction footprint (and Waiau Arm) and west of the Mararoa River.

The Project site has previously been extensively modified during the construction of the Manapōuri Power Scheme in the 1970s including construction of the MLC upstream from the confluence of the Mararoa and Waiau Rivers (Figure 3, Figure 4). Much of the landform on the former Mararoa Delta that was previously modified has been re-established in pasture. Crack willow treeland occurs in the western part of the Project Site associated with 'channels' extending from the Waiau Arm.

The theoretical Zone of Influence[12] (receiving environment) extends down the LWR to the coast, however, any discernible effects on riparian wetlands downstream of the Project site (i.e., effects related to sediment discharge (SSC and DFS)) are likely to occur closest to the Project site.

[12] The 'Zone of Influence' refers to all land, water bodies, and receiving environments that could be potentially affected by the construction and operation of the Project. It includes the Project site and any environments beyond the Project site where 'indirect effects' may extend.

Figure 3: *1964 aerial image of the Project site (sourced from http://retrolens.co.nz*[13] and licensed by LINZ CC-BY 3.0

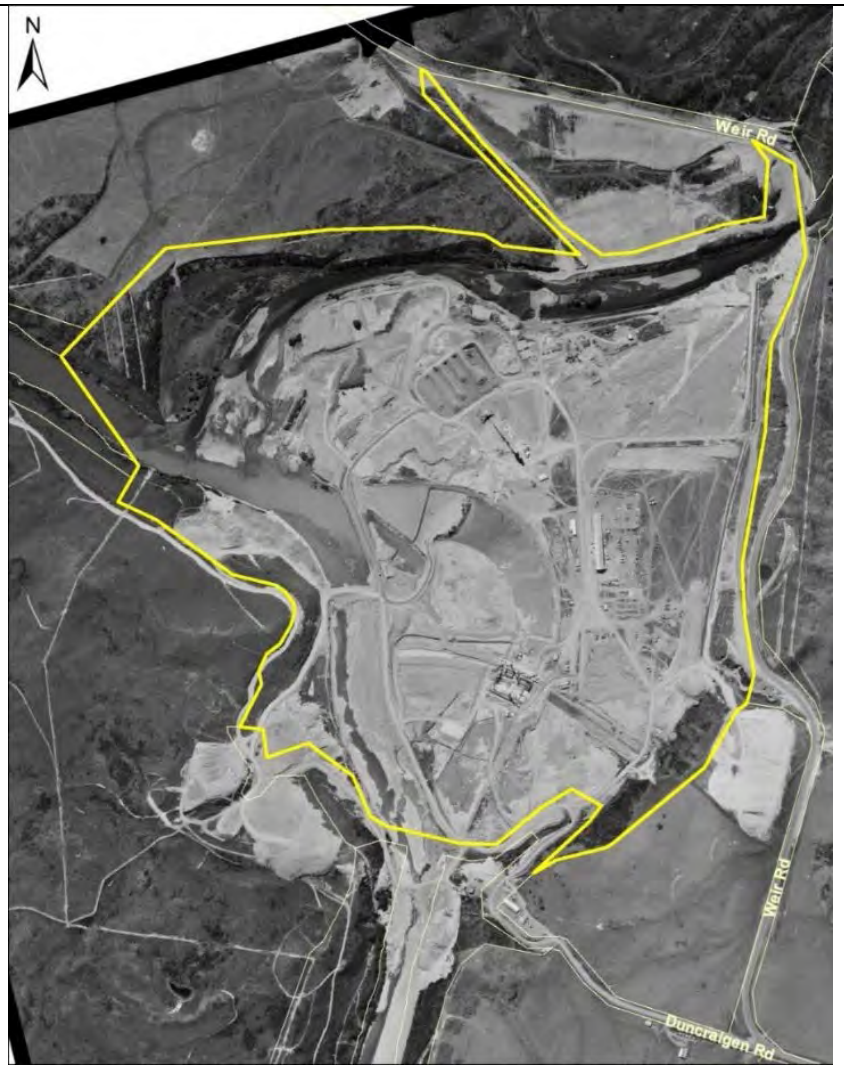

Figure 4: *1974 aerial image of the Project site (sourced from http://retrolens.co.nz and licensed by LINZ CC-BY 3.0*

[13] https://retrolens.co.nz/map/#/1185007.5313702228/4934838.296502392/1186518.3570072947/4935851.087127085/2193/12

4.2 Terrestrial Vegetation

4.2.1 Terrestrial Vegetation within the Parallel Channel Construction Footprint

The terrestrial vegetation within the construction footprint of the parallel channel is exotic grassland and crack willow treeland. These vegetation types are described below.

4.2.1.1 Exotic grassland

The terrestrial exotic grassland within the construction footprint of the parallel construction footprint is predominantly browntop grassland. This grassland also contains other exotic grasses and herbs including the grasses Yorkshire fog and crested dogstail, occasional herbs such as narrow-leaved plantain, white clover, catsear, lotus, hawkbit, dandelion and Californian thistle. In terms of the EIANZ EcIA method for determining ecological value (Roper-Lindsay et al. 2018), this vegetation is not representative, rare or distinct, diverse or of notable habitat pattern, nor of importance in terms of ecological context; it is of **Negligible** ecological value.

4.2.1.2 Crack willow treeland

Scattered mature crack willow trees are present in dryland areas (beyond the margins and hydrological influence of lacustrine 'channels') and form a treeland over the exotic grassland described above. In terms of the EIANZ EcIA method for determining ecological value (Roper-Lindsay et al. 2018), this vegetation is not representative, rare or distinct, diverse or of notable habitat pattern, nor of importance in terms of ecological context; it is of **Negligible** ecological value.

4.2.2 Terrestrial Vegetation within the Spoil Disposal and Contractor's Establishment Areas

The terrestrial vegetation of the former Mararoa River delta within the excavation and spoil disposal and contractor's establishment areas is an exotic grassland dominated by exotic Yorkshire fog, sweet vernal, perennial ryegrass, crested dogstail, and cocksfoot. Eucalypt trees have recently (within c.18 months) been planted into the grassland via ripping but at the time of the December 2022 survey remained small (typically c. 0.5 m). The historic modifications to the Project site (Figure 4, and see Appendix 3, Photos 1-2) are obvious on the ground, as the landform surface is uneven, contains boulders and rocks of various sizes (some partly buried, others exposed by recent ripping). In terms of the EIANZ EcIA method for determining ecological value (Roper-Lindsay et al. 2018), this vegetation is not representative, rare or distinct, diverse or of notable habitat pattern, nor of importance in terms of ecological context; it is of **Negligible** ecological value.

4.3 Wetlands

4.3.1 Wetland Habitats Potentially Affected by Construction of the Parallel Channel

4.3.1.1 Palustrine Wetlands

Wetland 1 is the only 'natural inland wetland' proposed to be removed during excavation of the parallel channel. It is a small, narrow feature occupying the edge of an existing dirt access road. It comprises a cluster of tall wīwī (fan-flowered rush, *Juncus sarophorus*) plants. Within the vegetation plot placed within this wetland, wīwī was 60% cover. No other indigenous species were present, and various exotic grasses and herbs each contributed 2-6% cover. It is considered a wetland because it passes the 'rapid test,' 'dominance test,' and 'prevalence index' wetland vegetation delineation methods (Ministry for the Environment 2021, 2022), and no minimum size for wetland features under these methods strictly applies[14].

Nevertheless, it is likely too small (122 m^2) to provide distinct or important fauna habitat (although, as was observed in Wetland 11, breeding kahu / swamp harrier pairs may breed in clumped rushes such as this). It does not contain representative vegetation (and occurs on an effectively artificial / highly modified landform), rare[15], diverse, distinct habitat, and is not of importance in terms of its ecological context. It is of Low ecological value.

4.3.1.2 Lacustrine Wetlands / 'Channels'

There are three lacustrine 'channels' on the northern bank of Waiau Arm. The southern ends of these channels are within the construction footprint of the proposed parallel channel (Figure 1). The distribution and extent of wetland plant communities within these 'channels' is primary driven by inundation from the Waiau Arm, to which they are connected. The extent and frequency of this inundation is dependent on water levels in Lake Manapōuri (and Waiau Arm). However, the western-most channel is also fed by ground and surface water flow from the toe of the terrace to the channel's north and west. The eastern-most and middle 'channels' dry out entirely when lake levels are low.

The benthic plant communities in the Waiau Arm within the Project site are described in Section 5.4 of NIWA's (2023) report and are not described or assessed in this report.

The native fish and freshwater fauna of the three channels at the Mararoa Delta are described in the Freshwater Assessment Memorandum appended to this report (Appendix 4)[16].

The main wetland plant communities and habitats associated with these lacustrine 'channels' are shown in Table 1.

[14] Ministry for the Environment's 'Pasture Exclusion Assessment Methodology' (Ministry for the Environment 2022) guidance suggests that "wet patches" smaller than the minimum plot size (4 m^2) can be ignored when they occur in an otherwise dryland area. Wetland 1 is approx. 122 m^2 and should therefore be treated as a wetland.

[15] Although wetland habitats generally all have some importance in terms of rarity (in that naturally occurring wetlands have been reduced to less than 20% of their former extent nationally), patches of wīwī rushes in exotic grassland are not a rare feature.

[16] This information has been compiled from the desktop information listed in the limitations and assumptions section of the memo.

Table 1: *Wetland vegetation types associated with the three lacustrine 'channels'*

Wetland vegetation types	Location in relation to Construction Footprint	Photographs (refer Appendix 3
Shallow open water (mudwort – water milfoil mudfield during low lake levels)[17]	Within and outside construction footprint	Photo 3
Creeping bent – hawkbit grassland or herbfield	Within and outside construction footprint	Photo 4
Jointed rush rushland	Outside / north of construction footprint	Photo 5
Spearwort – sharp spike sedge herbfield	Outside / north of construction footprint	Photo 6
Crack willow treeland	Within, but largely outside construction footprint	Photo 7

Each of these wetland plant communities and habitats is described below.

Within areas that are usually inundated (i.e. are shallow open water during 'normal' lake levels) and particularly in the deeper parts of these 'channels', during low lake levels there were extensive areas of bare, unvegetated mudfield (deposited fine sediment). At higher elevations, in areas that are still regularly inundated, macrophytes were present. This vegetation was typically comprised of a sparse cover of low stature indigenous species including mudwort, water milfoil, red pondweed, *Lobelia perpusilla* and gratiola. Yellow marsh cress, sharp spike sedge and Gaudichaud's sedge were also present, but infrequent, in higher, less infrequently inundated areas. Within the lacustrine 'channels' these areas are both within, and north of, the proposed construction footprint.

Less frequently inundated areas on the margins of the former river channels (both within and north of the construction footprint) were typically comprised of exotic dominated creeping bent – hawkbit grassland or herbfield growing amongst embedded cobbles, gravels or bare substrate. Other characteristic plant species in this community were occasional jointed rush and infrequent curled dock, as well as very infrequent dryland plant species that had recently colonised such as catsear, white clover, narrow-leaved plantain and the grasses Yorkshire fog and sweet vernal. Indigenous wetland species were very infrequent but included Gaudichaud's sedge and purple wind grass. The indigenous herb *Euchiton involucratus* was locally common in places and the rush *Juncus australis* was also present in a small number of locations. The cover of cobbles and bare ground was typically high where this plant community occurred.

The exotic dominated jointed rush rushland community primarily occupied small areas in depressions in the eastern channel north of, and outside, the construction footprint where standing water stays for longer following inundation. Species diversity was very low and was

[17] The classification of these areas changes depending on lake levels. During higher levels they are inundated and are shallow open water (part of Waiau Arm), but during lower lake levels they are predominantly mudfield.

characterised by frequent jointed rush and hawkbit with occasional creeping bent and very infrequent purple wind grass.

There was a small patch of spearwort – sharp spike sedge herbfield in one location in a former channel on the margin of the crack willow treeland north of, and outside, the construction footprint. This plant community was dominated by exotic species; primarily spearwort and marsh bedstraw but indigenous sharp spike sedge was also frequent. Other occasional species were the exotic water forget-me-not, jointed rush and *Alopecurus* sp.

Crack willow trees of up to approximately 15 m in height occur as treeland on the western side of the Project site (Photo 7, Appendix 3). Open water channels under the canopy in the western-most channel are frequently inundated by Waiau Arm. The understory of the crack willow treeland in this area is generally open and characterised by exotic herbs and grasses including frequent creeping bent, monkey musk, blue sweet grass and occasional water forget-me-not, selfheal, jointed rush, creeping buttercup, lotus and Yorkshire fog. Indigenous wetland plants were present in wetter areas within the crack willow treeland but were typically infrequent. They included swamp sedge, localised areas with a few plants of *Carex secta*, and very infrequent Sinclair's sedge, Glen Murray tussock and the fern swamp kiokio. Elsewhere, crack willow trees grow over creeping bent – hawkbit grassland or herbfield or terrestrial exotic grassland (Section 4.2.1.2)

The artificially constructed channel on the eastern side of the wetland is inundated to a varying degree during higher lake levels, with the part of the channel further from Waiau Arm being inundated only very frequently during very high lake levels. The distribution and extent of the vegetation in this channel appeared to be determined by elevation / inundation, the presence of depressions that hold water for longer and substrate. Parts of this channel supports wetland vegetation (Photo 8, Appendix 3) with cobbles, gravel and sparse dryland herbs and grasses in less frequently inundated areas. The substrate was typically cobbles and / or silt, with mud in the most frequently inundated part of the channel nearest Waiau Arm. Generally, the areas of hydrophytic vegetation in this eastern channel are highly modified and dominated by exotic species such as frequent hawkbit and creeping bent, occasional jointed rush (jointed rush rushland described above occurs in deeper depressions) and curled dock and infrequent spearwort, water-forget-me-not, marsh bedstraw, blue sweet grass, *Alopecurus* sp., oval sedge, South American rush and track rush. There were few indigenous species, although purple wind grass and *Euchiton involucratus* were frequent in more elevated, drier areas, and sharp spike sedge was occasional in wetter depressions. Sinclair's sedge, Gaudichaud's sedge and Buchanan's sedge (At Risk – Declining) were also present but only very infrequently and in localised areas.

The ecological value of the combined area has been assessed using the EIANZ EcIA method (Roper-Lindsay et al. 2018). Some areas of this overall area contain representative species and species assemblages typical of lacustrine wetland habitats (e.g. sharp spike sedge, and areas of mudwort, water milfoil and *Lobelia perpusilla*). This vegetatation is of moderate rarity (it only generally occurs on stable river or lake margins, or in wetlands) and contains an At Risk – Declining species; but, it has low-moderate indigenous species diversity and habitat pattern. The overall area is likely of moderate importance in terms of ecological context, as it provides a sequence including habitats for fauna along a gradient of freshwater (lake margin) to dryland, and likely provides breeding and feeding habitat for a small range of widespread and common indigenous bird species (e.g. grey warbler). It is of **Moderate** ecological value.

4.3.2 Palustrine Wetlands in the Vicinity of the Spoil Disposal and Contractor's Establishment Areas

Likely because of the uneven land surface and modified soil structure in the area proposed for the spoil disposal and contractor's establishment areas, slight depressions / low points support isolated patches of wet tolerant plant species including indigenous and exotic rushes and sedges, exotic herbs, and exotic wetland grasses. Some of these areas contain sufficient wetland vegetation (based on vegetation plot assessment) to be considered wetlands in terms of the RMA and NPS-FM. In many cases this was because single large individuals or clumps of wetland species such as wīwī rushes (*Juncus edgariae* and *J. sarophorus*) dominated the small 2x2 m vegetation plots.

Twelve small areas of wetland vegetation were identified in the vicinity of the spoil disposal and contractor's establishment areas (see Table 2 and Figure 5). All were small areas of palustrine marsh (44 – 1,588 m^2 in extent) dominated by exotic plant species. Most areas found to be wetlands supported only weakly hydrophytic vegetation, with the dominant cover comprising Facultative / FAC or Facultative Wetland / FACW plant species rather than Obligate / OBL species. Wetlands typically occupied small faint hollows in the generally hummocky terrain where it is likely that water impounds following rain; all areas are likely to be only infrequently wet and were dry at the time of the survey.

Four of these areas (Wetlands 6, 7, 8, and 9) occur on land that is below (and would at times be connected to) the maximum permitted operating level of Lake Manapōuri (Figure 5 and see Appendix 3, Photos 11-12); they are hence considered part of the bed of the lake.

Wetland areas were dominated by exotic grass, herb, rush, and sedge species, with a variable component of taller wīwī rushes (*Juncus edgariae* and *J. sarophorus*). The vegetation is typical of highly modified areas and comprises species that are tolerant of or likely to have established since historic site works were completed. Typical exotic species included kneed foxtail, Yorkshire fog, creeping bent, lotus, clover species, marsh bedstraw, spearwort, oval sedge, jointed rush, and soft rush (*J. conglomeratus*). Notable indigenous species present included the At Risk – Declining species Buchanan's sedge (present in Wetland 8 only, and other lake margin areas), and a small number of individuals or patches of sharp spike sedge, Glen Murray tussock, Gaudichaud's sedge, and pūkio / swamp sedge (all Not Threatened). Wetland 11 contained an active kahu / swamp harrier nest at the time of the survey, located in a clump of rushes.

These wetland areas are generally of Low ecological value, being neither representative nor diverse or of notable habitat pattern. Areas of Low-Moderate value (as opposed to Low value, see Table 2) featured a greater range of indigenous plant species; they rate higher as their overall value 'scoring' is generally improved by a diversity rating of low rather than very low. Being wetlands, which have been severely reduced nationally to less than 20% of their original extent, all are of at least moderate rarity (although wīwī rushes in pasture, and wetlands at the ED level are not rare). They provide limited habitat for fauna (e.g. kāhu / swamp harrier breeding) not otherwise provided by the prevailing exotic grassland.

Table 2: *Wetland areas identified in the vicinity of the proposed spoil disposal area and contractor's establishment area.*

Wetland No.	Area (m^2)	Vegetation Type	Within Lake Bed?*	Ecological Value	Notes
1	122	Wīwī rushland	No	Low	Very small, alongside, and likely created by access road
2	81	Wīwī - Yorkshire fog grassland	No	Low	
3	1588	Wīwī / kneed foxtail - sweet vernal grassland	No	Low	Larger area with depression, more clearly wet
4	270	Kneed foxtail - sweetgrass grassland	No	Low	Terrace toe area - essentially continuous features
5	44	Wīwī - oval sedge rushland	No	Low	
6	91	Kneed foxtail - creeping buttercup - oval sedge grassland	Yes	Low	
7	906	Crack willow / kneed foxtail treeland	Yes	Low	
8	692	Creeping bent grassland	Yes	Low-Moderate	Contains small number of Buchanan's sedge (At Risk – Declining).
9	304	(Wīwī) / kneed foxtail - creeping bent grassland	Yes	Low-Moderate	Somewhat more diverse compared to other areas: contains three indigenous *Carex* species and two indigenous *Juncus* species.
10	383	Marsh bedstraw - kneed foxtail - Gaudichaud's sedge grassland	No	Low	
11	100	Wīwī - Yorkshire fog grassland	No	Low-Moderate	Extremely small similar features in low-lying parts of hummocked area. Kahu breeding in Wetland 11.
12	286	Wīwī - Yorkshire fog grassland	No	Low	

File Ref: BM220277_102_A3L_Wetland_Extents_and_Lake_Level.mxd

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Data Sources:
Land Information New Zealand

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Maximum Permitted Lake Level
- Wetland Extents
- Cadastre

MANAPOURI LAKE CONTROL IMPROVEMENT PROJECT

Wetland Extents and Plot Locations

Date: 13 October 2023 | Revision: 0

Plan prepared for Meridian Energy by Boffa Miskell Limited

Project Manager: scott.hooson@boffamiskell.co.nz | Drawn: BMc | Checked: SHo

Figure 5

4.3.3 LWR Riparian Wetlands (Downstream of the MLC)

As discussed in Section 4.1, the Zone of Influence (receiving environment for sediment (SSC and DFS) generated at the Project site) extends down the LWR to the coast. There are numerous wetlands between MLC and the coast, but many of these are elevated above the river and do not have a surface water connection with the LWR, even during high flow events (Boffa Miskell 2009, Scott Hooson and Jaz Morris *pers. obs* 2020). No effects are possible on these wetlands that do not have a surface water connection with the LWR and these wetlands are not considered here. Further, as noted by NIWA (2023), any discernible effects on riparian wetlands downstream of the Project site are likely to occur closest to the Project site because the effects of the proposed Project on suspended sediment will vary down the LWR due to dilution, as additional flow joins the LWR (e.g., tributary flows) and as coarser fractions fall out of suspension and are deposited on the bed.

Table 3 lists the riparian wetlands (those wetlands known or likely to receive flood inflows from the LWR) between MLC and the LWR confluence with the Monowai River (approximately 23 km downstream of MLC) and these wetlands are shown in Figure 6. Other than the Maraora Weir Wetland immediately downstream of the weir at MLC, there are no riparian wetlands between MLC and Excelsior Creek, the proposed monitoring location on the LWR[18].

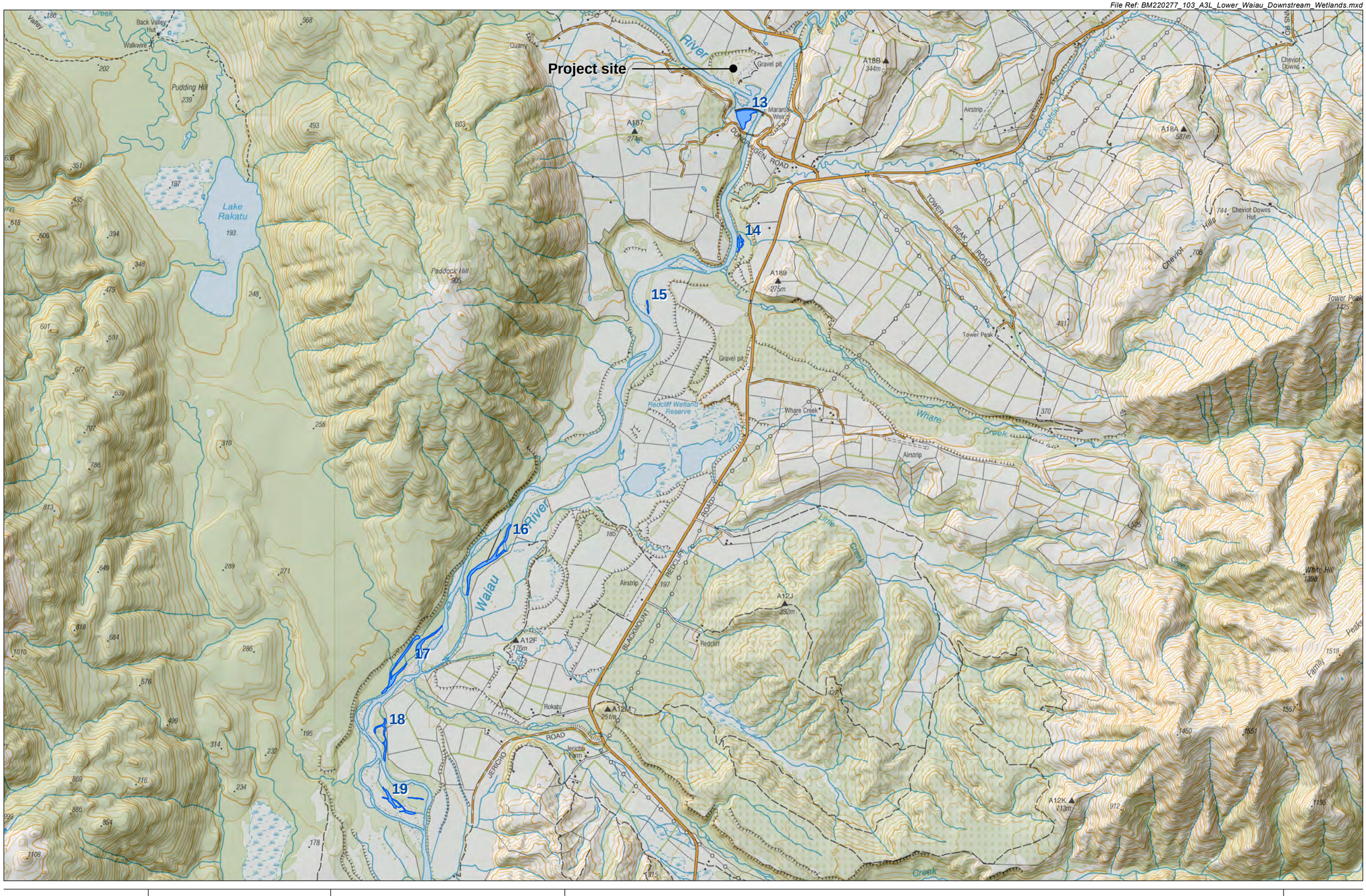
Table 3: *LWR riparian wetlands between MLC and the Monowai River confluence.*

Wetland No.	Approx. area (ha)	Wetland name	Ecological Value	Approx. distance downstream of Project site (km)[19]
13	4.73	Mararoa Weir Wetland	Moderate	0.0
14	0.76	Tower Peak Terrace Toe Wetland	Moderate	1.98
15	2.53	North of Redcliff Wetland	Low	4.22
16	4.46	Rakatu Riparian Wetland	Moderate	8.80
17	5.89	Opposite Redcliff Creek Wetland	Moderate	10.63
18	1.64	Redcliff Side Braid Wetland	Moderate	12.56
19	2.12	Jericho Road Island Wetland	Moderate	13.63

[18] Suspended sediment release from the excavation will be monitored for the duration of the excavation using a turbidity sensor installed in the LWR about 100 m upstream of the confluence with Excelsior Creek (refer to Figure 3-3 in NIWA 2023). This location is approximately 1,300 m from the downstream breakout area.

[19] Measured using river length from MLC to the top / upstream end of each wetland (rather than the straight-line distance between MLC and the wetland).

File Ref: BM220277_103_A3L_Lower_Waiau_Downstream_Wetlands.mxd



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Data Sources:
Land Information New Zealand

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

Downstream Riparian Wetlands

MANAPOURI LAKE CONTROL IMPROVEMENT PROJECT

Downstream Riparian Wetlands between MLC and Monowai River

Date: 13 October 2023 | Revision: 0

Plan prepared for Meridian Energy by Boffa Miskell Limited

Project Manager: scott.hooson@boffamiskell.co.nz | Drawn: BMc | Checked: SHo

Figure 6

4.3.3.1 Mararoa Weir Wetland

Mararoa Weir Wetland (Photos 13-14, Appendix 5) is a riverine marsh with areas of shallow water. Its total area is approximately 4.73 ha. It is an induced wetland that has formed on a riparian floodplain / flat basin following construction of the Mararoa Weir and MLC. This wetland likely has a strong hydrological connection to the LWR with groundwater the likely main driver, although river inundation is probably important during high flood flows due to overtopping of the weir and / or elevated water levels. Terrace seepage is also likely a minor hydrological influence on the wetland. The main vegetation communities within the wetland are sharp spike sedge rushland, spearwort herbfield, jointed rush rushland and mudwort – water milfoil mudfield, with most areas having a substantial cover of mud / silt substrates. There is an extensive area of indigenous dominated sharp spike sedge rushland, but generally, exotic plant species cover is high, and exotic plants are present throughout. An area of mudfield habitat is typical of this sparsely vegetated substrate in these types of habitats. This wetland has been assessed as being of **Moderate** ecological value.

4.3.3.2 Tower Peak Terrace Toe Wetland

Tower Peak Terrace Toe wetland (Photos 15-16, Appendix 5) includes 0.76 ha of combined riverine and palustrine swamp and marsh areas, with patches of shallow water. The wetland is generally perched above the LWR in two ‘upper’ and ‘lower’ sections; neither are strongly connected with the LWR and terrace seepage is likely the main hydrological influence on the wetland. Possibly, the lower wetland is also influenced by flood inflows. The main vegetation communities are (harakeke) / Pūrei tussockland and exotic grass grassland. From the information available, this wetland has been assessed as being of **Moderate** ecological value.

4.3.3.3 North of Redcliff Wetland

The North of Redcliff wetland (Photos 17-18, Appendix 5) lies within an abandoned channel and is a riverine system consisting of shallow water covering 2.53 ha. River groundwater and occasional river inundation are likely the most important hydrological influences, and there is a strong connection between the wetland and the LWR. Terrace seepage is also likely a minor hydrological influence on the wetland. The main vegetation community is exotic tall fescue grassland. From the information available, this wetland has been assessed as being of **Low** ecological value.

4.3.3.4 Rakatu Riparian Wetland

The Rakatu Riparian wetland (Photos 19-20, Appendix 5) is a riverine marsh with areas of shallow water covering 4.46 ha. The wetland has strong connections with the LWR, particularly through groundwater and flood inflows. The Southern extent of the wetland is also influenced by surface and groundwater outflow from the Rakatu wetland to a lesser extent. Main vegetation communities are crack willow forest, tall fescue grassland, and areas of open water with emergent water buttercup. From the information available, this wetland has been assessed as being of **Moderate** ecological value.

4.3.3.5 Opposite Redcliff Creek Wetland

The Opposite Redcliff Creek wetland (Photos 21-22, Appendix 5) is a 5.89 ha area of riverine and palustrine shallow water and swamp wetland. The wetland has strong hydrological connections with the LWR and river groundwater and flood inflows are main drivers, along with

surface water outflows. A stream and terrace seepages are also likely to have an important hydrological influence on the wetland that is independent of the LWR. The main vegetation communities are varied and include open water, rautahi / exotic grass grassland on the margins, toetoe / exotic grass grassland and mānuka – mingimingi shrubland. From the information available, this wetland has been assessed as being of **Moderate** ecological value.

4.3.3.6 Redcliff Side Braid Wetland

The Redcliff Side Braid wetland (Photos 23-24, Appendix 5) is a riverine marsh with areas of shallow water. It covers 1.64 ha. The wetland has a strong hydrological connection to the LWR and groundwater and flood inputs are main drivers, along with surface water outflows. The main vegetation communities are crack willow treeland, exotic grass grassland and mānuka scrub, the latter of which appears to have been sprayed off at some point. From the information available, this wetland has been assessed as being of **Moderate** ecological value, largely on the basis that some manuka may have survived or recover.

4.3.3.7 Jericho Road Island Wetland

The wetland on the Jericho Road Island (Photos 25-26, Appendix 5) is a riverine marsh covering 2.12 ha. The wetland has a strong hydrological connection to the LWR with groundwater the likely main driver, and river inundation is probably important during flood flows although the island appears relatively stable. The main vegetation communities are likely diverse and consist of turfland, herbfield, exotic grass grassland, and rautahi sedgeland, but are likely subject to regular disturbance from flood flows and / or river braid shifts (as part of a natural dynamic braided river system). From the information available, this wetland has been assessed as being of **Moderate** ecological value.

4.3.3.8 Summary of LWR Riparian Wetlands

In summary, seven riparian wetlands were identified between MLC and the LWR confluence with the Monowai River (approximately 23 km downstream of MLC). These wetlands support a range of wetland vegetation types. Of these, one was assessed as being of low ecological value and the remaining six are of moderate ecological value.

4.4 Lower Waiau River Hydrology / Flow Variability

The existing flow regime and flow variability in the LWR is described in detail in Section 6.1 of NIWA (2023).

4.5 Suspended and Deposited Fine Sediment

Information on the existing suspended and deposited fine sediment in the LWR is described in detail in Section 6.2 of NIWA (2023).

4.6 Ecological Significance

4.6.1 Identified Significant Sites

Southland District Council has not listed any SNAs in the operative Southland District Plan.

There are no 'Regionally Significant Wetlands' within the Project site, but part of the channel excavation area is contained within Environment Southland's 'Regionally Significant Wetlands and Sensitive Waterbodies' GIS layer[20] as a 'sensitive waterbody' named 'Waiau River Lake Manapouri to Mararoa Weir'. Environment Southland consider this area to be regionally significant, but 'sensitive waterbody' is not defined in the planning maps or proposed Southland Water and Land Plan (pSWLP).

Appendix 2 of the SRPS lists lake margins as a 'Rare Habitat Type'. The margins of Waiau Arm could be considered part of the margin of Lake Manapōuri. The relevant part of the biological description provided for lake margins in Appendix 2 of the SRPS is:

"Lake margins support a range of indigenous aquatic and terrestrial plants adapted to varying degrees of inundation. These are emergent, floating, submerged or rafted plants, rushes, reeds, sedges, sedgeland, flaxland, reedland turf (< 3 cm tall), herbfield (low turfs), and terrestrial vegetation such as scrub, shrubs, treeland and forest on the margins that are periodically inundated."…. "Exotic species (aquatic, wetland or terrestrial) may also be present."

4.6.2 Assessment of Significance

Following our site investigations, we assessed the ecological significance of the terrestrial and wetland areas that could potentially be impacted by the Project. The criteria for assessing whether a site is ecologically significant are listed in Appendix 3 of the Southland Regional Policy Statement (SRPS; Environment Southland 2017). Table 4 evaluates the Project site against each of these criteria. Italicised text is from Appendix 3 of the SRPS.

[20] From the proposed Southland Water and Land Plan (decisions version, operative in part). Many pSWLP provisions relating to wetlands are subject to appeal.

Table 4: *Evaluation of the Project site against the Southland Regional Policy Statement (Environment Southland 2017) criteria for determining significant indigenous vegetation and significant habitat of indigenous fauna.*

Criteria	Criteria met?	Explanation
Representativeness		
(i) *Indigenous vegetation or habitat of indigenous fauna that is representative, typical or characteristic of the natural diversity of the relevant ecological district or coastal biogeographic region. This can include degraded examples where they are some of the best remaining examples of their type, or represent all that remains of indigenous biodiversity in some areas.*	No	The Project site does not have indigenous vegetation or habitat of indigenous fauna that is representative, typical or characteristic of the natural diversity of the relevant ecological district. The area has previously been extensively modified during the construction of the MLC (refer to Figure 4). Much of the terrestrial vegetation on the landform on the former Mararoa Delta has been re-established in young Eucalypt trees and exotic pasture and is not representative. The twelve small areas of wetland vegetation in the vicinity of the spoil disposal and contractor's establishment areas have likely established because of the uneven land surface and modified soil structure. The predominantly exotic vegetation within these wetland areas is typical of highly modified areas and comprises species that have established since historic site works were completed. They are not representative. The three lacustrine 'channels' on the northern bank of Waiau Arm are also modified and dominated by exotic vegetation. The eastern channel was artificially constructed and the two western-most channels have formed in the former bed of the Mararoa River delta following construction of the MLC structure and Mararoa Diversion Cut. There are areas of indigenous dominated macrophytes / mudfield in those areas that are inundated by Waiau Arm, but most of the wetland vegetation is dominated by exotic plant species. This criterion is not met.
(ii) *Indigenous vegetation or habitat of indigenous fauna that is a relatively large example of its type within the relevant ecological district or coastal biogeographic region.*	No	The Project site does not support any indigenous vegetation or habitats that are relatively large examples of their type within the ecological district. This criterion is not met.
Rarity/Distinctiveness		
(iii) Indigenous vegetation or habitat of indigenous fauna that has been reduced to less than 20% of its former extent in the Region, or relevant land environment, ecological district, freshwater	No	The Project site is on a land environment (L1.1c) where there is 10-20% indigenous cover left nationally (Walker et al. 2015). With the exception of indigenous plants growing amongst exotic dominated vegetation, there is

environment, or coastal biogeographic region.		no indigenous vegetation and limited habitat of indigenous fauna within the Project site. Wetlands have been reduced to less than 20% of their former extent in the Region and biogeographic unit (7.9% and 10.8% of Southland's former freshwater wetlands remain in the Southland Region and Southland biogeographic unit, respectively (Ausseil et al. 2008)). The small wetlands in the vicinity of the spoil disposal and contractor's establishment areas that are on a constructed landform are dominated by exotic wetland vegetation and are not considered significant under this criterion. This criterion is not met.
(iv) Indigenous vegetation or habitat of indigenous fauna that supports an indigenous species that is threatened, at risk, or uncommon, nationally or within the relevant ecological district or coastal biogeographic region.	Yes	Those wetland areas and margins of the Waiau Arm within the Project site that support the nationally At Risk – Declining plant Buchanan's sedge are significant under this criterion.
(v) The site contains indigenous vegetation or an indigenous species at its distribution limit within Southland Region or nationally.	No	The Project site is not known to contain indigenous vegetation or indigenous species at their distribution limit within the Southland Region or nationally. This criterion is not met.
(vi) Indigenous vegetation or an association of indigenous species that is distinctive, of restricted occurrence, occurs within an originally rare ecosystem, or has developed as a result of an unusual environmental factor or combinations of factors.	Yes? (in part)	The Project site does not support indigenous vegetation or an association of indigenous species that is distinctive. Lake margins are an originally rare ecosystem[21] (Williams et al. 2007). The margins of the Waiau Arm within the Project site have been modified by the historic construction of the MLC and are substantially more modified than many other areas of Lake Manapouri's margins. Those less modified areas that support indigenous macrophyte / mudfield communities could be considered significant under this criterion.
Diversity and Pattern		
(vii) *Indigenous vegetation or habitat of indigenous fauna that contains a high diversity of indigenous ecosystem or habitat types, indigenous taxa, or has changes in species composition reflecting the existence of diverse natural features or ecological gradients.*	No	The vegetation and habitats within the Project site support a low diversity of ecosystem and habitat types, a low - moderate diversity of indigenous wetland plant species and a low diversity of indigenous fauna. The twelve small areas of wetland vegetation in the vicinity of the spoil disposal and contractor's establishment areas also support a low diversity of wetland plant species and fauna. The Project site does not include areas that have changes in species composition that reflect the existence of diverse natural

[21] Also referred to as historically rare ecosystems or naturally uncommon ecosystems.

		features or ecological gradients. This criterion is not met.
Ecological Context		
viii) Vegetation or habitat of indigenous fauna that provides or contributes to: an ecological linkage, ecological corridor or network; buffering function; or ecosystem service.	No	The vegetation and habitats within the Project site are generally not well buffered and are surrounded by modified, exotic dominated terrestrial vegetation communities and habitats. They are considered unlikely to play an important role in terms of ecological linkages, networks, or corridors. The three lacustrine 'channels' on the northern bank of Waiau Arm are connected to the Waiau Arm and may have a minor role as a stepping stone for shallow water waders and waterfowl between Lake Manapōuri and wetlands in the Lower Waiau River. This criterion is not met.
(ix) A wetland which plays an important hydrological, biological or ecological role in the natural functioning of a water body, including a river or coastal system, or springs, lakes and streams.	No	The small areas of wetland vegetation in the vicinity of the spoil disposal and contractor's establishment areas are not connected with any waterbodies and do not play an important hydrological, biological or ecological role in the natural functioning of a water body. Due to their modified nature, the three lacustrine 'channels' on the northern bank of Waiau Arm are not known to play an important hydrological, biological or ecological role in the natural functioning of Waiau Arm. This criterion is not met.
(x) Indigenous vegetation or habitat of indigenous fauna that provides important habitat (including, but not limited to, refuges from predation, or key habitat for feeding, breeding, or resting) for indigenous species, either seasonally or permanently.	No	The wetland and terrestrial vegetation within the Project site do not provide important habitat for indigenous species, either seasonally or permanently. The lacustrine channels provide habitat for a small number of indigenous wetland and water bird species. The small areas of wetland vegetation in the vicinity of the spoil disposal and contractor's establishment areas provide limited habitat for fauna (e.g. kāhu / swamp harrier breeding) not otherwise provided by the predominant cover of exotic grassland in the surrounding area. This criterion is not met.

In summary, those wetland and lake margin areas of the Project site that support the nationally At Risk – Declining plant Buchanan's sedge are significant under the rarity / distinctiveness criterion iv, and the relatively less modified margins of the Waiau Arm within the Project site that support indigenous macrophyte / mudfield communities could be considered ecologically significant under the rarity / distinctiveness criterion vi. Other areas of the Project site do not meet the threshold for significance under the criteria in Appendix 3 of the SRPS.

5.0 Project Shaping

Following completion of wetland and terrestrial ecology surveys, including the detailed wetland vegetation survey to determine whether areas within the proposed channel excavation and spoil deposition works area and environs contain 'natural inland wetlands', project shaping advice was provided to Meridian that recommended that:

- To avoid effects on wetlands 2-11, the proposed spoil disposal area and contractor's establishment area should be set-back from those natural inland wetland areas by a minimum of 10 m.

6.0 Assessment of Ecological Effects

This section assesses the actual and potential effects of the Project on the terrestrial ecology and wetland values discussed in Section 4.0. The level of effect is assessed in this section **without** the effects management measures recommended in Section 7.0, but **with** the implementation of site management that is part of the Project and project shaping as outlined in Section 5.0.

The magnitudes of effect are generally described at the scale of an affected feature itself (i.e., the specific scale of the wetland), and at the scale of the Project site for wetlands within the Project site. In addition, the magnitude of effects is described at the ED scale (i.e., in comparison to the general extent of wetlands and similar habitats, or the general abundance / distribution of their constituent indigenous species, at the ED scale). For the purposes of this assessment, in determining overall effects of the proposal, the ED scale is considered most appropriate, as it provides a consistent benchmark against which to compare various degrees of impact to various ecological features.

The actual and potential effects of the Project on freshwater habitats and fauna in the three channels at the Mararoa Delta due to loss of connection from Waiau Arm during excavations are assessed in the Freshwater Assessment Memorandum appended to this report (Appendix 4).

6.1 Vegetation and Habitats within the Construction Footprint

Vegetation clearance to construct the parallel channel and haul road would lead to loss of the existing vegetation within the construction footprint, including lacustrine vegetation. Table 5 shows the approximate extent of vegetation clearance based on overlap between the proposed construction footprint and the extent of the vegetation communities described in Section 4.3.1 and mapped in Figure 7. Effects on areas of Negligible ecological value (i.e., terrestrial / dryland areas comprised of exotic grassland) are not described or considered further in this assessment.

Table 5: *Extent of vegetation clearance.*

Vegetation Type	Location	Vegetation / habitat clearance (ha)
Exotic grassland	Primarily within spoil disposal area and contractor's establishment area	16.31
Crack willow treeland	Lacustrine 'channels'	0.70
Wīwī rushland	Wetland 1	0.012 (122 $m^{2)}$
Creeping bent – hawkbit grassland and herbfield	Lacustrine 'channels'	0.46
Shallow open water (mudwort – water milfoil mudfield during low lake levels)[22]	Lacustrine 'channels'	1.26

6.1.1 Wetland 1

Wetland 1 is entirely within the proposed channel excavation footprint and this feature would be removed by proposed works. In terms of the indigenous values present, these are solely the presence of fan-flowered rush (*Juncus sarophorus*). This species is common and widespread in the immediate area (the Project site), the wider area (Upukerora ED, and Mavora Ecological Region), and nationally (this species is classified as Not Threatened; de Lange et al. 2018). In terms of the EIANZ EcIA methodology (Roper-Lindsay et al. 2018), the loss of a small number of individuals of this species through removal of the wetland would be a Very High[23] magnitude of effect at the scale of the wetland itself (the wetland would be permanently and completely removed), but a Negligible[24] magnitude impact at the Project site and ED scale. A Negligible magnitude impact on Low ecological value corresponds to a **Very Low** level of effect.

[22] The classification of these areas changes depending on lake levels. During higher levels they are inundated and are shallow open water (part of Waiau Arm), but during lower lake levels they are predominantly mudfield.

[23] A Very High magnitude impact means a '*total loss of, or very major alteration, to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether AND/OR Loss of a very high proportion of the known population or range of the element / feature.*' Only the first criteria would apply in this instance and at this assessment scale; loss of this feature would have no effect whatsoever on the population or range of wīwī rush nor the extent of wetlands generally, whether at the site, ED, or national scale.

[24] A Negligible magnitude impact means a '*very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; AND/OR Having a negligible effect on the known population or range of the element / feature.*'

File Ref: BM220277_104_A3L_VegetationMapping.mxd

Boffa Miskell

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0 100 m

1:4,000 @ A3

Data Sources:
Land Information New Zealand, Damwatch Ltd.

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

Vegetation and Habitat Types
- Crack willow treeland
- Creeping bent – hawkbit grassland, herbfield
- Exotic grassland
- Shallow open water

- Wetlands
- Construction Footprint
- Cadastre

MANAPOURI LAKE CONTROL IMPROVEMENT PROJECT

Extent of Vegetation and Habitat Clearance

Date: 08 November 2023 | Revision: 0

Plan prepared for Meridian Energy by Boffa Miskell Limited

Project Manager: scott.hooson@boffamiskell.co.nz | Drawn: BMc | Checked: SHo

Figure 7

6.1.2 Lacustrine 'Channels'

Potential effects to hydrophytic vegetation in 'channel' areas adjacent to the parallel channel and haul road could arise from construction works, due to:

- Earthworks and vegetation clearance at the southern end of the channels (closest to Waiau Arm) to construct the parallel channel and haul road (permanent effect, or temporary effect in areas where e.g., the haul road is removed and the channel connection to the Waiau Arm reinstated);
- Sedimentation and smothering of wetland / lacustrine vegetation due to the above works (temporary effect);
- Temporary loss of hydrological connection to Waiau Arm during construction due to construction of haul road; and
- Hydrological changes resulting from temporary de-watering and loss of surface water connection.

6.1.2.1 Earthworks and vegetation clearance

Construction of the parallel channel and haul road would lead to loss of lacustrine vegetation within the 'lacustrine channels' including indigenous hydrophytic and macrophyte plant species. Generally, these are nationally Not Threatened species that are common locally (e.g., *Lobelia perpusilla, water milfoil*) and that are expected to re-establish in suitable lacustrine margins of the newly constructed channel. Based on the total extent of clearance, and likely re-establishment of similar species following construction, the magnitude of effect is Low. For an area of overall Moderate ecological value, this equates to a **Low** overall level of effect.

Earthworks and vegetation clearance would also affect a nationally At Risk – Declining species (Buchanan's sedge; at the time of the December 2022 survey there were <10 plants within the construction footprint). Removal of <10 Buchanan's sedge plants has been assessed as a Low magnitude of effect[25] at the scale of the Project site, where there are likely >100 plants. At the scale of the Upukerora ED the magnitude of this effect is considered Negligible. A Low level of effect on a species of High ecological value is a **Low** level of effect. However, these plants are also an ecologically significant feature of the Project site (refer to Section 4.6.2); remediation is recommended in Section 7.1.2, to achieve no net loss.

The removal of approximately 0.7 ha of crack willow treeland and trees of Negligible ecological value (both within the lacustrine channels and in adjacent dryland locations) is not of concern from an ecological perspective. However, to prevent spread of living plant material, it is recommended that all willow material is removed (including stumps and root balls) and either mulched or disposed of appropriately) to prevent it from re-growing. If mulched, material should be mulched away from water and as finely as possible. If the mulch is used, it should be used away from water to ensure fragments don't re-sprout.

6.1.2.2 Sedimentation / smothering and loss of hydrological connection

Construction of bunds and the haul road will mean there will be no surface water connection between Waiau Arm and the three lacustrine channels for the duration of excavation works. Culverts will be placed under the haul road during its construction to allow road access to remain along the remainder of the new channel bank once the excavated channel is complete,

[25] Having a minor effect on the known population or range of the element/feature.

and restore direct hydraulic connectivity to the eastern-most and middle 'channels' once the parallel channel is in service. The elevated haul road across the western-most lacustrine channel will be removed during Stage 3 of the excavation. Overall, it is expected that there will be no surface water connection to the three lacustrine channels for up 15 weeks. There will continue to be groundwater connection to these channels over this period (Land Water People, 2023) and the western channel is expected to continue to receive freshwater flows from the toe of the terrace to its west and north. Construction of the haul road and any de-watering sumps will create sediment that has the potential to affect the hydrophytic vegetation and macrophytes present in the three lacustrine channels.

Sedimentation and smothering of habitat, or loss of hydrological connection could both reduce the condition or health of, or kill, the hydrophytic vegetation and macrophytes present, but overall, would not result in long-term changes to, or the permanent removal of, this habitat following construction. Because there will continue to be groundwater connection to these channels and the western channel is expected to continue to receive freshwater flows from the toe of the terrace to its west and north, the magnitude of this temporary effect is considered to be Low. Hydrophytic vegetation and macrophytes are that are killed are expected to re-establish in these habitats following completion of the Project and rehabilitation works. Those plants whose health is impacted would recover over time. For an area of overall Moderate ecological value, a Low magnitude of effect equates to a **Low** overall level of temporary effect. Recommendations in respect of sediment management are provided in Section 7.0).

6.1.2.3 Hydrological changes due to temporary de-watering

Partial de-watering of the excavation area is being considered to reduce the proportion of excavation work performed by long-reach excavators. This would involve excavating large sumps adjacent to the excavation area in the eastern-most and middle 'channels'[26] and using submersible pumps to draw down the local groundwater level by pumping to a remote seepage pond. It is anticipated that pumping to lower water levels within the excavation could only be potentially practicable for the first half of the Stage 2 duration, or approximately 4 weeks (Damwatch 2023). It is understood the excavated sumps would be re-filled and rehabilitated to the original contour following completion of the channel excavation works.

If sumps are used in these locations, this will likely lower the water level in, or remove any water present in these eastern-most and middle lacustrine 'channels' for the approximately 4 weeks that the dewatering would be undertaken. It may also result in drawdown of water in wetland habitats associated with the 'western channel'. However, all three channels are subject to drying during low lake levels and the wetland vegetation is tolerant of these conditions. Both the eastern and middle channels dry out completely during periods of low lake levels. Consequently, a temporary (4 week) reduction in groundwater levels associated with the proposed dewatering does not represent a departure from normal hydrological conditions occurring in these lacustrine channels. The magnitude of this temporary effect is Low. For an area of overall Moderate ecological value, this equates to a **Low** overall level of temporary effect.

[26] Refer to Appendix C, Drawing E2243-107 of Damwatch (2023).

6.2 Vegetation and Habitats in the Vicinity of the Spoil Disposal and Contractor's Establishment Areas

The proposed spoil disposal area and other ancillary works (e.g., the contractor's establishment area, see Figure 1) have been designed to avoid Wetlands 2-11, and a setback of at least 10 m from these areas would apply.

As described in Damwatch's Report (2023), to prepare the spoil disposal area, existing topsoil would be stripped and stockpiled prior to spoil deposition, for later reuse as capping material. Spoil deposition will occur across approximately 12 ha of the former Mararoa River Delta area (120,000 m^3). It is anticipated that this will be spread to an average depth of 1.9 m. Following these works, topsoil would be spread, the site would be re-contoured, and grass would be sown across the site. Setup activities within the contractor's establishment area will include clearing vegetation and identifying and / or constructing flat areas within an area of approximately 20,000 m^2. The potential effects of these works include:

- Vegetation removal within the spoil disposal area and contractor's establishment area;
- Sediment and stormwater runoff to wetlands (particularly or only Wetlands 2-9) during initial topsoil stripping and vegetation removal, during formation of bunds, and following spoil deposition but prior to topsoil capping and rehabilitation with grass (temporary effect);
- Increased runoff of rainfall to wetlands from the final landform / slopes of the spoil disposal area, which may have relatively low permeability due to compaction (permanent / ongoing effect); and
- Hydrological changes resulting from temporary partial de-watering.

6.2.1.1 Earthworks and terrestrial vegetation clearance

As described in Section 4.2.2, the vegetation within the spoil disposal area and contractor's establishment area is exotic grassland with *Eucalyptus* trees that have recently been planted into the grassland. This vegetation is of Negligible ecological value. The magnitude of the effect of removing this vegetation is Low and level of effect is **Very Low**.

6.2.1.2 Sediment and stormwater runoff into wetlands

Sediment and stormwater runoff is proposed to be avoided by implementation of erosion and sediment control measures, including creation of bunds surrounding the spoil deposition area. However, if this system were to fail, and sediment were to run off to any wetland, impacts would range from slight deposition of fine sediment to complete burial (temporary loss). Wetlands 2-9 contain a relatively low proportional cover of a small number of indigenous sedge and rush species, all of which are common in the wider area (ED) and nationally (all are Not Threatened). Effects, at the scale of each wetland, would range from Negligible (if fine sediment were to enter the wetland) to Very High (if a wetland were effectively filled in). Notably, these areas of wetland vegetation have arisen following a history of repeated earthworks at the Site, demonstrating that similar features would likely re-establish following disturbance (if not in the same location, at some other low point where rainfall runs off). At the scale of the wider area (ED), fine sediment impacts or even the loss of all of these wetland features would constitute, at worst, a Low[27]

[27] A Low magnitude impact means a '*minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances/patterns; AND/OR Having a minor effect on the known population or range of the element / feature.*'

magnitude impact. A Low magnitude impact on Low or Low-Moderate ecological values corresponds to a **Very Low-Low** level of effect.

6.2.1.3 Increased runoff of rainfall into wetlands

Increased rainfall runoff is likely to either not affect or potentially benefit these wetlands, which presently support only weakly hydrophytic vegetation (mostly FAC or FACW species, rather than OBL species). This may mean increased water levels or prolonged inundation / saturated soils, increasing in turn the range of habitat niches for wetland species (within limits; all these existing wetland features are very small). The magnitude of effect is either no change or a slight Positive effect, resulting in (for Low or Low-Moderate ecological values) either **No Effect** or possibly a slight **Net Gain**.

6.2.1.4 Hydrological changes to wetlands due to temporary de-watering

The proposed dewatering of the parallel channel excavation will lower natural groundwater levels across a significant proportion of the Project site during the initial phase of Stage 2 excavations (approximately 4 weeks) (Land Water People, 2023). The small areas of palustrine marshes in the vicinity of the proposed spoil disposal area and contractor's establishment area occupy small faint hollows in the generally hummocky terrain. It is likely that, in terms of their hydrology, rainwater is the primary driver for the presence of hydrophytic vegetation in these areas. All of these wetlands contain only weakly hydrophytic vegetation and any hydraulic connection between the wetlands identified and the underlying water table is likely to occur on an infrequent basis associated with periods when lake levels are well above their normal operating range. Land Water People (2023) have concluded that a temporary reduction in groundwater levels associated with the proposed dewatering of the parallel channel excavation is likely to result in a less than minor effect on the hydrology of these features. As a consequence, the magnitude of effect of temporary de-watering on these wetlands that are of Low and Low- Moderate ecological value is likely to be Negligible, resulting in a **Very Low** level of effect.

Land Water People (2023) note that temporary mounding of the water table around the proposed seepage pond north of Wetland 3[28] may result in a net positive effect on the hydrology of Wetland 3 by elevating the water table to a level typically only occurring during high stage events in the Mararoa River. However, this effect would be temporary and only occur when water was being pumped into the seepage pond (i.e. over approximately 4 weeks). The magnitude of effect on Wetland 3 is considered to be Negligible, and long-term will have No Effect on Wetland 3.

6.3 Downstream Wetlands

6.3.1 Changes in flow in LWR during construction stage

Any changes to flow in the LWR are expected to be of a minor nature. The main change is that for the duration of the Project Mararoa River flows will be released directly through MLC and down the LWR. For the duration of the Project:

- Minimum flows will be provided in the LWR (i.e., 16 m^3/s January to March, 12 m^3/s from May to September, and 14 m^3/s in October);

[28] Refer to Appendix C, Drawing E2243-107 of Damwatch (2023).

- Monthly recreational flows will continue to be released (approximately 35 m^3/s for 24 hours on the last Sunday of the month from Jan – April and October);
- Flushing flows for the management of nuisance periphyton in the LWR that generally average at least 120 m^3/s over 24 hours and reach a peak flow of around 160 m^3/s will continue to be released (if there is the flow conveyance capacity to pass flushing flows); and
- Flood flows will continue to be released during high lake levels (above the maximum control level of 178.6 m a.s.l.)[29].

As described in Section 4.3.3, most wetlands downstream of MLC have hydrological influences that are independent of the LWR. Many receive inputs from the LWR only during flood conditions, and so are likely to already experience extended periods without receiving direct river inputs, i.e., when LWR flows are at or about existing consented minimum flows. Given the above, the magnitude of the effect on wetlands in the LWR downstream of the LWR has been assessed as Negligible at the individual wetland and ED scale, the level of effect on riparian wetlands (of Low to Moderate ecological value) is **Very Low**.

6.3.2 Potential sedimentation and smothering of wetland vegetation in riparian wetlands

The Project will result in increased levels of SSC and DFS in the LWR (refer to NIWA 2023). Increased SSC and DFS have the potential to smother wetland vegetation and habitats downstream of the MLC where they are associated with the riparian margin of the LWR.

NIWA (2023) expect the most noticeable effects of suspended sediment will be in the reaches immediately downstream of the MLC. This is because the effects of the proposed Project on suspended sediment are expected to decrease in a downstream direction from the Project site due to dilution, as additional flow joins the LWR (e.g., tributary flows) and as coarser fractions fall out of suspension and are deposited on the bed.

Because construction works are proposed to be completed under generally low flow conditions, (refer to Section 2.3) fine sediment deposition will occur in the wetted bed of the river, rather than in riparian wetlands which are elevated above the normal river level. Under minimum flow conditions (12 – 16 m^3/s) and monthly recreational flows (approximately 35 m^3/s) no effects on riparian wetlands will occur.

The only time sediment deposition in riparian wetlands is possible is as a result of the re-suspension, transportation of sediment during large natural or managed flow events in the LWR. Construction works will be timed to be undertaken when the risks of flood events are lowest, and lake levels will be managed (as far as possible) to reduce the risk of spill / flood events. However, when Lake Manapōuri is above 187.6 m a.s.l. flood rules will apply and is therefore, a chance that flood flows could during the duration of the Project.

In terms of the existing environment, high flows in the Mararoa River naturally result in turbid flows entering the LWR and infrequent levels of elevated suspended sediment in the Mararoa River represent normal (natural) occurrences for this river. Because turbid flows in the Mararoa River are passed directly through MLC and down the LWR, high DFS cover has already been

[29] At lake levels above the maximum control level of 187.6 m a.s.l. when flood flows occur conditions will likely be unsuitable for the excavation works.

observed in parts of the LWR at times (NIWA 2023). NIWA describe the natural conditions (i.e. the existing environment) in relation to suspended and deposited sediment in their report.

Based on the natural range of turbidity experienced in the LWR, NIWA (2023) have developed thresholds for SSC and DFS (described in detail in Section 3 of their report). The components of this approach, including the sediment thresholds, are described in detail in NIWA (2023). These sediment thresholds have been designed to allow additional sediment inputs that are no more than those experienced naturally by biota in the LWR. NIWA note that provided the thresholds are adhered to, any temporary exacerbation will lie within the range of natural variability. Further, the release of sediment will be temporary. The duration of release of the highest sediment loads (during the upstream and downstream breakout excavations) is expected to be relatively short (5– 7 weeks) with the largest release of sediment will be during the 4-week period when the downstream 'breakout' is completed. The effect of the Project is therefore likely to be an increase in sediment loads within the range that occurs naturally in the LWR, but over a longer duration than would occur naturally.

Following channel excavation, NIWA's assessment is that SSC and DFS in the LWR would be expected to return to its usual state through gradual transport of sediment downstream, especially during large natural and managed flow events.

Based on NIWA's conclusion that if the thresholds for SSC and DFS described in their report are adhered to, and any temporary exacerbation will lie within the range of natural variability, we have assessed the magnitude of effect of sedimentation on riparian wetlands downstream of the project site as Negligible (i.e., approximating to the "no change" situation) at the individual wetland and ED scale. The level of effect on riparian wetlands of Low to Moderate ecological value is **Very Low**.

6.3.3 Improved flushing flows

The primary purpose of the Project is to reduce velocities and thus hydraulic head losses through the Mararoa delta area when large flow rates are released from the MLC gates, allowing greater reliability in flow releases including flushing flows of 160 m^3/s able to be released at lower lake levels than is currently possible (Damwatch 2023). Improving flushing flows down the LWR is generally expected to either not affect or potentially benefit downstream riparian wetlands. Potentially, flushing flows may contribute to wetland recharge and excluding dryland weeds via increased water levels or prolonged inundation / saturated soils, increasing in turn the range of habitat niches for wetland species. On the other hand, flushing flows (as opposed to much larger flood flows) may not be large enough to influence or inundate relatively higher elevation wetland areas, meaning that improved flow conveyance has no effect. The magnitude of effect ranges from No Effect to a slight Positive effect, resulting in (for Low or Low-Moderate ecological values) either **No Effect,** or possibly, a slight **Net Gain**.

6.4 Summary of Assessment of Effects

Table 6 summarises the actual and potential effects of the Project on terrestrial and wetland ecology values assuming no effects management (as recommended in Section 7.0), but assuming the implementation of project shaping (Section 5.0) and site management that is part of the Project as outlined in Section 2.0.

Table 6: *Summary of the actual and potential effects of the Project on terrestrial and wetland ecology values assuming no mitigation (as recommended in Section 7.0), but assuming implementation of Project shaping and site management recommendations that are proposed as part of the Project.*

Ecosystem Component	Ecological Value	Nature of Effect	Magnitude of Effect	Level of Effect
Vegetation and Habitats within the Construction Footprint				
Removal of Wetland 1	Low	Permanent	Negligible	Very Low
'Lacustrine Channels': earthworks and vegetation clearance	Moderate	Temporary & permanent	Low	Low
'Lacustrine Channels': sedimentation and smothering, temporary loss of hydrological connection	Moderate	Temporary	Low	Low
'Lacustrine Channels': hydrological changes due to temporary de-watering	Moderate	Temporary	Low	Low
Spoil Disposal and Contractor's Establishment Areas				
Earthworks and terrestrial vegetation clearance	Negligible	Temporary	Low	Very Low
Sediment and stormwater runoff into wetlands	Low - Moderate	Temporary	Low	Very Low - Low
Increased runoff of rainfall from final landform into wetlands	Low - Moderate	Permanent	No change - slight Positive	No Effect - slight Net Gain
Hydrological changes resulting from temporary partial de-watering	Low - Moderate	Temporary	Negligible	Very Low
Downstream Wetlands				
Changes in flow in LWR during construction stage	Low – Moderate	Temporary	Negligible	Very Low
Sedimentation and smothering of wetland vegetation in riparian wetlands	Low – Moderate	Temporary	Negligible	Very Low
Improved flushing flows	Low - Moderate	Long-term	No change - slight Positive	No Effect - slight Net Gain

7.0 Recommendations and Residual Effects

7.1 Recommendations

The following effects management measures are recommended to avoid, minimise or remedy the actual or potential adverse effects of the construction and operation of Meridian's proposed "parallel channel" on wetlands and terrestrial vegetation. These recommendations are in addition to the changes adopted during the Project shaping stage of the project (Section 5.0).

The level of effects of the Project on terrestrial vegetation and wetlands, as summarised in **Table 7** in Section 6.4, range from **No Effect** or **slight Net Gain** to **Low**. Very Low level effects can generally be classed as 'not more than minor' effects (refer to Appendix 2) and effects management is not considered necessary. Similarly No Effects or a Net Gain do not require management. However, management measures are required for those components of the Project that result in Low levels of effect. They are:

- Earthworks and vegetation clearance, sedimentation and smothering and loss of hydrological connection on the 'lacustrine channels', including the removal of plants of the nationally At Risk – Declining species Buchanan's sedge*;* and
- Sediment and stormwater runoff effects on wetlands in the Vicinity of the Spoil Disposal and Contractor's Establishment Areas.

Recommendations to manage these effects are provided below.

The recommendations from the Freshwater Assessment Memorandum (refer to Appendix 4) to manage effects on freshwater fauna in the three channels at the Mararoa Delta have been included in this section.

7.1.1 Avoid and Minimise

Recommendations to avoid and / or minimise actual or potential adverse effects on vegetation and habitats are as follows:

- To ensure no part of any wetland within the vicinity of the spoil disposal and contractor's establishment areas are cleared or disturbed during works, it is recommended that:
  - Prior to works commencing in the spoil disposal and contractor's establishment areas (i.e., stripping or vegetation and topsoil), a minimum 10 m set-back from each wetland boundary is clearly marked (with waratahs or stakes painted with bright dazzle or similar) by a suitably qualified ecologist.
  - Contractors are briefed on avoiding disturbance or damage to those wetlands.
- Appropriate and best practice erosion and sediment control measures are put in place prior to initial topsoil stripping and vegetation removal and formation of bunds to avoid sediment discharge into the small wetlands adjacent to the spoil disposal and contractor's establishment areas. The erosion and sediment control measures / devices should be inspected and maintained in accordance with best practice guidance. Small-scale measures (e.g., straw bales and silt fences) may be needed given the small size of each wetland in this area.

- Appropriate and best practice erosion and sediment control measures are put in place to avoid / minimise sediment discharge into the lacustrine 'channels' during construction works.
- To prevent spread from crack willow trees as a result of their removal, it is recommended that all willow material is removed (including stumps and root balls) and either mulched or disposed of appropriately) to prevent it from re-growing. If mulched, material should be mulched away from water and as finely as possible. Mulch should only be used well away from water to ensure fragments don't re-sprout.

Recommendations to avoid and / or minimise actual or potential adverse effects on freshwater fauna (from the Freshwater Assessment Memo, Appendix 4) are as follows:

- To avoid disturbance, injury, or mortality to freshwater fauna during the installation of the haul road and culverts in the channels, a suitably qualified and experienced freshwater ecologist must develop and implement a Freshwater Fauna Management Plan. This plan shall include:
    - Measures to avoid and minimise effects on freshwater fauna in areas where surface water is present at the time of construction works.
    - To avoid or minimise impacts on kākahi, if present, a survey for this species shall be undertaken prior to works commencing. The findings of this survey will inform the appropriate avoidance or minimisation measures, such as kākahi re-location, if kākahi are present in low densities and there is suitable alternative habitat nearby, and these management measures will be included in the Freshwater Fauna Management Plan.
    - Capturing and relocating fish and other fauna from the Channels both within the footprint of the haul road and from any connected freshwater habitat upstream of the work footprint immediately prior to construction works.
    - Advice around timing construction works to occur outside of critical periods, where practicable, as noted in the Freshwater Report.
    - Methods shall follow national guidelines (Ministry for the Environment, 2021) and as advised by a suitably qualified freshwater ecologist experienced in construction projects.
- To avoid or minimise ecological effects due to temporary loss of hydrological and ecological connection between Channel 3 and Waiau Arm, capture and relocation of freshwater fish present within connected freshwater habitat upstream of the work footprint shall be carried out immediately prior to construction works and in accordance with the Freshwater Fauna Management Plan.

7.1.2 Remedy

Recommendations to remedy actual or potential adverse effects on vegetation and habitats are as follows:

- Transplant all Buchanan's sedge plants from within the construction footprint of the parallel cut to a suitable area of lacustrine habitat within the Project site (but outside the construction footprint). The survival of transplanted plants should be monitored after 12

months, and any plants that do not survive transplanting should be replaced with plants sourced from locally collected seed.

Recommendations to avoid and / or minimise actual or potential adverse effects on freshwater fauna (from the Freshwater Assessment Memo, Appendix 4) are as follows:

- A suitably qualified freshwater ecologist with experience in construction projects and fish passage shall provide advice on the site rehabilitation methodology to ensure fish passage between Channel 3 and Waiau Arm is reinstated on completion of the Project.

7.2 Assessment of Residual Effects

The following table summarises the results of Sections 4, 5, 6 and 7. It provides an assessment of the level of residual effects following implementation of Project shaping (Section 5.0) and the effects management measures recommended in (Section 7.1).

Table 7: *Summary of predicted effects, proposed effects management and residual effects after the implementation of avoidance, minimisation and remediation measures.*

Type of Impact	**Predicted Level of Effect Without Impact Management Measures**	**Summary of Effects Management Measures Recommended**	**Residual Level of Effects after Implementation of Effects Management Measures**
Vegetation and Habitats within the Construction Footprint			
Removal of Wetland 1	Likely complete removal of small, Low value wetland; **Very Low** level of effect.	None proposed	**Very Low**
'Lacustrine Channels': earthworks and vegetation clearance	Loss of existing lacustrine vegetation including indigenous plant species that are expected to re-establish in suitable lacustrine margins of the newly constructed channel; **Low** level of effect.	Remove all willow material and either mulch or dispose of it appropriately to prevent it from re-growing.	**Low**
Removal of Buchanan's sedge plants.	Removal of <10 At Risk – Declining Buchanan's sedge plants resulting in a **Low** level of effect.	Transplant Buchanan's sedge to a suitable area of lacustrine habitat within the Project site with follow-up monitoring of survival and replacement if required.	Effects otherwise mitigated by translocation. **Very Low** level of effect.
'Lacustrine Channels': sedimentation and smothering, temporary loss of hydrological connection	Temporary sedimentation and smothering of vegetation and habitats, or loss of hydrological connection reduce the condition of, or kill hydrophytic vegetation and macrophytes; **Low** level of effect.	Use of best practice erosion and sediment control measures.	Effects minimised by use of erosion and sediment control measures. **Low** level of effect.
'Lacustrine Channels': hydrological changes due to temporary de-watering	Temporary removal of any water in eastern-most and middle lacustrine 'channels' and potential for drawdown in wetland habitats associated with the 'western channel' for the approximately 4 weeks; **Low** level of effect on relatively tolerant wetland habitats.	None proposed	**Low**

Spoil Disposal and Contractor's Establishment Areas Wetlands			
Earthworks and terrestrial vegetation clearance	Removal of exotic grassland with Eucalypt trees of Negligible ecological value; Very Low level of effect.	None proposed	**Very Low**
Sediment and stormwater runoff into wetlands	Very Low – Low level of effect.	Spoil disposal area set-back from wetlands by > 10 m. Implementation of erosion and sediment control measures including creation of bunds surrounding the spoil deposition area.	Effects minimised by 10 m set-backs and use of erosion and sediment control measures; **Very Low** level of effect.
Increased runoff of rainfall from final landform into wetlands	Increased rainfall runoff from raised spoil disposal area potentially increasing water levels or prolonged inundation / saturated soils in adjacent wetlands; No Effect - slight Net Gain.	N/A	**No Effect - slight Net Gain.**
Hydrological changes resulting from temporary partial de-watering	Temporary reduction in groundwater levels resulting in a less than minor effect on the hydrology of wetlands with only weakly hydrophytic vegetation; Very Low level of effect.	None proposed	**Very Low** level of effect.
Downstream Wetlands			
Changes in flow in LWR during construction stage	Minor changes in flow in LWR for duration of Project; Very Low level of effect on riparian wetlands.	None proposed	**Very Low** level of effect.
Sedimentation and smothering of wetland vegetation in riparian wetlands	Sediment deposition in riparian wetlands during large natural or managed flow events in the LWR; Very Low level of effect.	Project design, including avoiding working instream as much as possible. Adherence to thresholds for, and monitoring of, SSC and DFS (refer NIWA 2023)	**Very Low** level of effect.
Improved flushing flows	Potential for positive effects through contribution to wetland recharge, exclusion of dryland weeds and increases in the range of habitat niches for wetland species, but flushing flows may not be large enough to influence or inundate wetland areas; either No Effect - slight Net Gain	N/A	**No Effect - slight Net Gain**

8.0 Summary and Conclusions

- This assessment has identified that:
  - The terrestrial vegetation within the proposed construction footprint of the parallel channel is exotic grassland and crack willow treeland of negligible ecological value and the terrestrial vegetation within the excavation channel and spoil disposal and contractor's establishment areas is exotic grassland and young planted Eucalyptus trees; also of negligible ecological value.
  - There are 12 small areas of palustrine marsh that support wetland vegetation in the vicinity of the spoil disposal and contractor's establishment areas. All these wetland areas are likely to be only infrequently wet, supported only weakly hydrophytic vegetation and were dominated by exotic plant species, although some supported indigenous wetland plant species. Nine wetland areas were of low ecological value and the remaining three were of low – moderate ecological value. Project shaping advice was provided to Meridian that recommended setting-back the proposed spoil disposal area and contractor's establishment areas from these wetlands by a minimum of 10 m to avoid effects on those features.
  - Seven riparian wetlands were identified downstream of the Project site between MLC and the LWR confluence with the Monowai River (approximately 23 km downstream of MLC). One wetland was assessed as being of low ecological value and the remaining six were of moderate ecological value.
  - Those areas of the Project site that meet the threshold for significance under the criteria in Appendix 3 of the SRPS are wetland and lake margin areas of the Project site that support the nationally At Risk – Declining plant Buchanan's sedge and potentially, the relatively less modified margins of the Waiau Arm that support indigenous macrophyte / mudfield communities.
- The actual and potential effects of the Project on wetlands and terrestrial vegetation include:
  - The removal of small (122 m^2), low value palustrine marsh (Wetland 1) which is within the proposed channel excavation footprint. In terms of the indigenous values present, these are solely the presence of the common and widespread fan-flowered rush. The level of effect of the removal of this wetland has been assessed as **Very Low**.
  - Potential effects to hydrophytic vegetation and wetland habitats in 'lacustrine channel' areas adjacent to the parallel channel and haul road arising from earthworks and vegetation clearance at the southern end of the channels; sedimentation and smothering of wetland / lacustrine vegetation, temporary loss of hydrological connection to Waiau Arm during construction due to construction of a haul road and bunds, and hydrological changes resulting from temporary de-watering and loss of surface water connection. The level of these effects on wetland vegetation and habitats has been assessed as **Low**. Use of best practice erosion and sediment control measures are recommended to minimise temporary sedimentation and smothering of vegetation and habitats in these 'lacustrine channel' areas.
  - The removal of <10 At Risk – Declining Buchanan's sedge plants, which has been assessed as having a **Low** level of effect. However, these plants are also an

ecologically significant feature of the Project site so transplanting all affected plants to a suitable area of lacustrine habitat within the Project site, as well as follow-up monitoring of survival and replacement planting (if required), is recommended for this species.

- Removal of vegetation to establish the spoil disposal area and contractor's establishment area. The vegetation within these areas is exotic grassland and recently planted *Eucalyptus* trees of Negligible ecological value. The level of effect has been assessed as **Very Low.**
- Sediment and stormwater runoff to Wetlands 2-9 during initial topsoil stripping and vegetation removal, during formation of bunds and following spoil deposition. The level of these effects has been assessed as **Very Low - Low**. Implementation / installation of appropriate erosion and sediment control measures prior to initial topsoil stripping and vegetation removal and formation of bunds is recommended to avoid sediment discharge into these small wetlands.
- Increased runoff of rainfall to Wetlands 2-9 from the final landform / slopes of the spoil disposal area potentially increasing water levels or prolonging inundation and / or soil saturation. This effect has been assessed as either having **No Effect** or possibly a slight **Net Gain**.
- Hydrological changes to Wetlands 2-9 resulting from possible temporary partial dewatering of the parallel channel excavation. A temporary reduction in groundwater levels associated with the proposed dewatering of the parallel channel excavation has been assessed as having a less than minor effect on the hydrology of these features and a **Very Low** level of ecological effect.
- Minor changes in flow in the LWR for the duration of the Project are expected to have a **Very Low** level of effect on downstream riparian wetlands of Low to Moderate ecological value.
- Sedimentation and smothering of wetland vegetation in downstream riparian wetlands has also been assessed as **Very Low**, primarily because construction works are proposed to be completed under generally low flow conditions, meaning fine sediment deposition is less likely to occur in riparian wetlands which are elevated above the normal river level. Project design, including avoiding working instream as much as possible and adherence to thresholds for, and monitoring of, SSC and DFS will also minimise this potential effect.
- Improved flushing flows may benefit downstream riparian wetlands by contributing to wetland recharge, excluding dryland weeds and increasing the range of habitat niches for wetland species. However, flushing flows may not be large enough to influence or inundate relatively higher elevation riparian wetlands, meaning that improved flow conveyance may actually have no effect.

- Overall, the level of effect of the construction and operation of the Project on wetlands and terrestrial vegetation, with implementation of project shaping and other impact management recommendations, is generally expected to be Very Low to Low.

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Appendix 1: Plant Species Lists for the Project Site

Table A1.1 provides a list of the plant species recorded during surveys of the proposed spoil disposal area, contractor's establishment area and environs. Table A1.2 provides a list of the plant species recorded during surveys of the during a survey of the lacustrine 'channels' and environs.

Table A1.1: *Plant species list for the spoil disposal area, contractor's establishment area and environs (refer to* ***Figure 2*** *for the survey area).*

Species name	Common name	Threat Status[30]	Growth Form	Wet areas only	Dry areas only
*Achillea millefolium**	Yarrow		Dicot Herb		X
*Agrostis capillaris**	Browntop		Grass		
*Agrostis stolonifera**	Creeping bent		Grass	X	
*Aira caryophyllea**	Silvery hair grass		Grass		
*Alopecurus geniculatus**	Kneed foxtail		Grass		
*Aphanes arvensis**	Parsley piert		Dicot Herb		
*Bellardia viscosa**	Tarweed		Dicot Herb		
*Bromus hordeaceus**	Soft brome		Grass		
Carex breviculmis	Grassland sedge	Not Threatened	Grass		X
Carex buchananii	Buchanan's sedge	At Risk - Declining	Grass	X	
Carex coriacea	Cutty grass	Not Threatened	Grass	X	
Carex flagellifera	Glen Murray tussock	Not Threatened	Grass		
Carex gaudichaudiana	Gaudichaud's sedge	Not Threatened	Grass	X	
*Carex leporina**	Oval sedge		Grass		
Carex secta	Pūrei	Not Threatened	Grass	X	
Carex virgata	Pūkio / swamp sedge	Not Threatened	Grass	X	
*Cerastium fontanum**	Mouse-ear chickweed		Dicot Herb		
*Cirsium arvense**	Californian thistle		Dicot Herb		
*Cirsium vulgare**	Scotch thistle		Dicot Herb		
*Crepis capillaris**	Hawksbeard		Dicot Herb		

[30] Threat status determined according to the most recently available NZTCS data.

*Cynosurus cristatus**	Crested dogstail		Grass		
*Cytisus scoparius**	Broom		Shrub		
*Dactylis glomerata**	Cocksfoot		Grass		
*Digitalis purpurea**	Foxglove		Dicot Herb		
Eleocharis acuta	Sharp spike sedge	Not Threatened	Grass	X	
Epilobium species			Dicot Herb		
*Erodium cicutarium**	Storksbill		Dicot Herb		X
*Eucalyptus species**			Tree		
*Festuca rubra**	Chewings fescue		Grass		
*Galium palustre**	Marsh bedstraw		Dicot Herb	X	
Geranium brevicaule	Short-flowered cranesbill	Not Threatened	Dicot Herb		X
*Glyceria declinata**	Blue sweet grass		Grass	X	
*Hypericum perforatum**	St John's wort		Low Shrub		
Hypnum cupressiforme	Cypress-leaved plait moss		Non Vascular		
*Hypochaeris radicata**	Catsear		Dicot Herb		
*Juncus articulatus**	Jointed rush		Grass	X	
Juncus australis	Wīwī / leafless rush	Not Threatened	Grass		
*Juncus conglomeratus**	Soft rush		Grass		
Juncus edgariae	Wīwī / Edgar's rush	Not Threatened	Grass		
Juncus sarophorus	Wīwī / fan-flowered rush	Not Threatened	Grass		
*Juncus tenuis**	Track rush		Grass		
*Leontodon saxatilis**	Hawkbit		Dicot Herb	X	
*Leucanthemum vulgare**	Oxeye daisy		Dicot Herb		
*Linum catharticum**	Purging flax		Dicot Herb		
*Lolium arundinaceum**	Tall fescue		Grass		
*Lolium perenne**	Perennial rye grass		Grass		
*Lotus pedunculatus**	Lotus		Dicot Herb		
*Lupinus arboreus**	Tree lupin		Shrub		
*Luzula congesta**			Grass		
*Lysimachia arvensis**	Pimpernel		Dicot Herb		
Microtis unifolia	Onion-leaved orchid	Not Threatened	Orchid		
Muehlenbeckia axillaris	Creeping pōhuehue	Not Threatened	Climber/Vine		X
*Myosotis laxa**	Water forget-me-not		Dicot Herb	X	
*Navarretia squarrosa**	Californian stinkweed				
*Orobanche minor**	Broomrape		Dicot Herb		

*Persicaria maculosa**	Willow weed		Dicot Herb		
*Phleum pratense**	Timothy		Grass		
*Pilosella officinarum**	Mouse-ear hawkweed		Dicot Herb		
*Pinus species**	Unidentified *Pinus* species		Tree or Shrub		
*Piptatherum miliaceum** ?	Smilograss ?		Grass		
*Plantago lanceolata**	Narrow-leaved plantain		Dicot Herb		
Racomitrium species	Woolly moss		Non Vascular		X
*Ranunculus flammula**	Spearwort		Dicot Herb	X	
*Rumex acetosella**	Sheeps sorrel		Dicot Herb		
*Rumex crispus**	Curled dock		Dicot Herb		
*Rumex obtusifolius**	Broad-leaved dock		Dicot Herb		
Rytidosperma species			Grass		X
*Salix x fragilis**	Crack willow		Tree	X	
*Sedum acre**	Stone crop		Dicot Herb		X
*Sonchus asper**	Prickly sow thistle		Dicot Herb		
*Stellaria graminea**	Stitchwort		Dicot Herb		
*Taraxacum officinale**	Dandelion		Dicot Herb		
Thelymitra longifolia	White sun orchid	Not Threatened	Orchid		X
*Trifolium dubium**	Suckling clover		Dicot Herb		
*Trifolium pratense**	Red clover		Dicot Herb		
*Trifolium repens**	White clover		Dicot Herb		
Triquetrella papillata	Moss		Non Vascular		X
*Ulex europaeus**	Gorse		Shrub		
*Verbascum thapsus**	Woolly mullein		Dicot Herb		X
*Verbascum virgatum**	Moth mullein		Dicot Herb		
*Vulpia bromoides**	Vulpia brome grass		Grass		X

* Denotes exotic species.

Table A1.2: *Plant species recorded within the lacustrine 'channels' and environs.*

Common name	Scientific name	Threat Status[31]	Growth Form
Indigenous species			
Azolla rubra	Pacific azolla	Not Threatened	Fern
Blechnum minus	Swamp kiokio	Not Threatened	Fern
Callitriche petriei	Petrie's starwort	Not Threatened	Dicot Herb
Carex buchananii	Buchanan's sedge	At Risk - Declining	Grass
Carex flagellifera	Glen Murray tussock	Not Threatened	Grass
Carex gaudichaudiana	Gaudichaud's sedge	Not Threatened	Grass
Carex secta	Pūrei	Not Threatened	Grass
Carex sinclairii	Sinclair's sedge	Not Threatened	Grass
Carex virgata	Pūkio / swamp sedge	Not Threatened	Grass
Coprosma propinqua	Mikimiki	Not Threatened	Tree
Coprosma rhamnoides	Mikimiki	Not Threatened	Shrub
Eleocharis acuta	Sharp spike sedge	Not Threatened	Grass
Eleocharis gracilis	Slender spike sedge	Not Threatened	Grass
Euchiton involucratus		Not Threatened	Dicot Herb
Gratiola sexdentata	Gratiola	Not Threatened	Dicot Herb
Juncus australis	Leafless rush	Not Threatened	Grass
Juncus edgariae	Wīwī	Not Threatened	Grass
Juncus sarophorus	Fan-flowered rush	Not Threatened	Grass
Lachnagrostis striata	Purple wind grass	Not Threatened	Grass
Lemna disperma	Common duckweed	Not Threatened	Dicot Herb
Limosella lineata	Mudwort	Not Threatened	Dicot Herb
Lobelia perpusilla		Not Threatened	Dicot Herb
Moss sp.	Moss sp.	?	Non-vascular
Myriophyllum triphyllum	Water milfoil	Not Threatened	Low Shrub
Nitella sp.	Nitella sp.	Not Threatened	Non-vascular
Persicaria decipiens		Not Threatened	Dicot Herb
Potamogeton cheesemanii	Red pondweed	Not Threatened	Dicot Herb
Rorippa palustris	Marsh yellow cress	Not Threatened	Dicot Herb

[31] Threat status determined according to the most recently available NZTCS data.

Viola cunninghamii	Mountain violet	Not Threatened	Dicot Herb
Exotic species			
Agrostis stolonifera	Creeping bent		Grass
Aira caryophyllea	Silvery hair grass		Grass
Alopecurus sp.*	*Alopecurus* sp.		Grass
Anthoxanthum odoratum	Sweet vernal		Grass
Carex leporina	Oval sedge		Grass
Cirsium arvense	Californian thistle		Dicot Herb
Dactylis glomerata	Cocksfoot		Grass
Elytrigia repens	Couch		Grass
Erythranthe guttata	Monkey musk		Dicot Herb
Erythranthe moschata	Musk		Dicot Herb
Galium palustre	Marsh bedstraw		Dicot Herb
Glyceria declinata	Blue sweet grass		Grass
Holcus lanatus	Yorkshire fog		Grass
Hypochaeris radicata	Catsear		Dicot Herb
Juncus articulatus	Jointed rush		Grass
Juncus bufonius	Toad rush		Grass
Juncus effusus	Leafless rush		Grass
Juncus microcephalus	South American rush		Grass
Juncus tenuis	Track rush		Grass
Leontodon saxatilis	Hawkbit		Dicot Herb
Lotus pedunculatus	Lotus		Dicot Herb
Lysimachia arvensis	Pimpernal		Dicot Herb
Myosotis laxa	Water forger-me-not		Dicot Herb
Nasturtium officinale	Watercress		Dicot Herb
Plantago lanceolata	Narrow-leaved plantain		Dicot Herb
Plantago major	Broad-leaved plantain		Dicot Herb
Polygonum arenastrum	Small-leaved wireweed		Dicot Herb
Prunella vulgaris	Selfheal		Dicot Herb
Ranunculus flammula	Spearwort		Dicot Herb
Ranunculus repens	Creeping buttercup		Dicot Herb
Ranunculus trichophyllus	Water buttercup		Dicot Herb

Rubus fruticosus	Blackberry		Low Shrub
Rumex acetosella	Sheep's sorrel		Dicot Herb
Rumex crispus	Curled dock		Dicot Herb
Salix x fragilis	Crack willow		Tree
Spergularia rubra	Sand spurrey		Dicot Herb
Stellaria alsine	Bog stichwort		Dicot Herb
Taraxacum officinale	Dandelion		Dicot Herb
Trifolium repens	White clover		Dicot Herb
Verbascum thapsus	Woolly mullein		Dicot Herb

Appendix 2: Assessing Ecological Value and Level of Effects

Assessing Ecological Value

For communities, habitats and ecosystems we applied the four matters as described in the EIANZ guidance (Roper-Lindsay et al. 2018). Each of the four matters was assigned a score of "high", "moderate", "low" or "very low", based on the relevant attributes (Table A2.1).

The four scores were then combined to provide a single site score which ranges from "Very High" to "Negligible" based on the following system (refer to Table A2.2).

For species, we applied Table A2.3 to assign value to species as described in the EIANZ guidance (Roper-Lindsay et al. 2018).

Tables A2.1 – A2.5 are reproduced from the EIANZ EcIA Guidelines (Roper-Lindsay et al. 2018).

Table A2.1: *Attributes to be considered when assigning ecological value or importance to a site or area of vegetation / habitat / community for terrestrial ecosystems (from Roper-Lindsay et al. 2018).*

MATTERS	ATTRIBUTES TO BE CONSIDERED
Representativeness	Criteria for representative vegetation and aquatic habitats: - Typical structure and composition - Indigenous species dominate - Expected species and tiers are present - Thresholds may need to be lowered where all examples of a type are strongly modified Criteria for representative species and species assemblages: - Species assemblages that are typical of the habitat - Indigenous species that occur in most of the guilds expected for the habitat type
Rarity/distinctiveness	Criteria for rare/distinctive vegetation and habitats: - Naturally uncommon, or induced scarcity - Amount of habitat or vegetation remaining - Distinctive ecological features - National priority for protection Criteria for rare/distinctive species or species assemblages: - Habitat supporting nationally Threatened or At Risk species, or locally uncommon species - Regional or national distribution limits of species or communities - Unusual species or assemblages - Endemism
Diversity and pattern	- Level of natural diversity, abundance and distribution - Biodiversity reflecting underlying diversity - Biogeographical considerations – pattern, complexity - Temporal considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation

MATTERS	ATTRIBUTES TO BE CONSIDERED
Ecological context	- Site history, and local environmental conditions which have influenced the development of habitats and communities - The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (from "intrinsic value" as defined in RMA) - Size, shape and buffering - Condition and sensitivity to change - Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material - Species role in ecosystem functioning – high level, key species identification, habitat as proxy

Table A2.2: *Assigning overall value to areas (refer to Table 4 for the matters to be considered for terrestrial communities) (Roper-Lindsay et al., 2018).*

VALUE	DESCRIPTION
Negligible	Area rates Very Low for three matters and Moderate, Low or Very Low for remainder.
Low	Area rates Low or Very Low for majority of assessment matters and Moderate for one. Limited ecological value other than as local habitat for tolerant native species.
Moderate	Area rates High for one matter, Moderate and Low for the remainder, or Area rates Moderate for two or more assessment matters Low or Very Low for the remainder Likely to be important at the level of the Ecological District.
High	Area rates High for two of the assessment matters, Moderate and Low for the remainder, or Area rates High for one of the assessment maters, Moderate for the remainder. Likely to be regionally important and recognised as such.
Very High	Area rates High for three or all of the four assessment matters. Likely to be nationally important and recognised as such.

Table A2.3: *Criteria for assigning ecological value to species (Roper-Lindsay et al., 2018).*

ECOLOGICAL VALUE	SPECIES CLASSIFICATION
Negligible	Exotic species, including pests, species having recreational value.
Low	Nationally and locally common indigenous species.
Moderate	Species listed as any other category of *At Risk* (Recovering, Relict, Naturally Uncommon) found in the 'zone of influence' (ZOI) either permanently or seasonally; or Locally (ED) uncommon or distinctive species.
High	Species listed as *At Risk – Declining* found in the ZOI either permanently or seasonally.
Very High	*Nationally Threatened* (Nationally Critical, Nationally Endangered, Nationally Vulnerable) species found in the ZOI either permanently or seasonally.

Assessing Magnitude of Impact

Once the value of the ecosystem components had been determined, the magnitude of the impact was assessed. Magnitude is determined by a combination of scale (temporal and spatial) of effect and degree of change that will be caused in or to the ecological component. A typical scale of magnitude ranges from "Very High" to "Negligible" as shown in Table A1.4.

Table A2.4: *Criteria for describing magnitude of effect (Roper-Lindsay et al., 2018).*

MAGNITUDE	DESCRIPTION
Very High	Total loss of, or very major alteration, to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known population or range of the element / feature.
High	Major loss or major alteration to key elements/ features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed; AND/OR Loss of a high proportion of the known population or range of the element / feature.
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that post-development character, composition and/or attributes will be partially changed; AND/OR Loss of a moderate proportion of the known population or range of the element / feature.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances/patterns; AND/OR Having a minor effect on the known population or range of the element / feature.
Negligible	Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation; AND/OR Having a negligible effect on the known population or range of the element / feature.

Assessing Level of Effect

The overall level of the effect on each ecological feature was determined by combining the ecological value of the vegetation communities, habitats, ecosystems and / or sites (Table A1.2) or species (Table A1.3) and the magnitude of the impact (Table A1.4) using the matrix in Table A1.5.

Table A2.5. *Criteria for describing the level of effect (Roper-Lindsay et al., 2018).*

		ECOLOGICAL VALUE				
		Very High	High	Moderate	Low	Negligible
MAGNITUDE	Very High	Very High	Very High	High	Moderate	Low
	High	Very High	Very High	Moderate	Low	Very Low
	Moderate	High	High	Moderate	Low	Very Low
	Low	Moderate	Low	Low	Very Low	Very Low
	Negligible	Low	Very Low	Very Low	Very Low	Very Low
	Positive	Net Gain	Net Gain	Net Gain	Net Gain	Net Gain

The EIANZ EcIA guidelines (Roper-Lindsay et al. 2018) note that the level of effect can then be used as a guide to the extent and nature of the ecological management response required (including the need for biodiversity offsetting). For example:

- '**Very High**' represents a level of effect that is unlikely to be acceptable on ecological grounds alone (even with compensation proposals). Activities having very high adverse effects should be avoided.

- '**High**' and '**Moderate**' represents a level of effect that requires careful assessment and analysis of the individual case. Such an effect could be managed through avoidance, design, or extensive offset or compensation actions.
- '**Low**' and '**Very Low**' should not normally be of concern, although normal design, construction and operational care should be exercised to minimise adverse effects. If effects are assessed taking impact management measures developed during project shaping into consideration, then it is essential that prescribed impact management is carried out to ensure low or very low-level effects.
- '**Very Low**' level effects can generally be classed as 'not more than minor' effects.

Appendix 3: Photographs of Wetlands Within, and Adjacent to, the Spoil Disposal Areas

Photo 1: *Manapōuri Lake Control and Waiau Arm during high lake levels, looking downstream. The Mararoa River (channelised) is visible top left. Figure provided by Meridian / Nick Key.*

Photo 2: *The proposed spoil disposal area 3as seen from Weir Road, looking upstream with Waiau Arm at left.*

Photo 3: *Mudfield with a sparse cover of exposed macrophytes in lacustrine channel at west of Project site, during low lake levels.*

Photo 4: *Creeping bent – hawkbit herbfield in lacustrine channel at west of Project site.*

Photo 5: *Jointed rush rushland, in lacustrine channel at west of Project site.*

Photo 6: *Spearwort – sharp spike sedge herbfield, in lacustrine channel at west of Project site.*

Photo 7: *Crack willow treeland, in lacustrine channel at west of Project site.*

Photo 8: *The eastern-most lacustrine channel, approximately at the centre of the Project site but west of the spoil disposal area and north of and outside the construction footprint.*

Photo 9: *Typical wetland vegetation in the spoil deposition area (Wetland 3). Patches of wīwī rushes dominate 2 x 2 m vegetation plots and pass Ministry for the Environment (2020) wetland delineation tests.*

Photo 10: *This notable depression at the western end of Wetland 3 clearly supports wetland vegetation including indigenous sharp spike sedge and exotic spearwort and jointed rush, with fringing rushes.*

Photo 11: *Wetland vegetation at terrace toe at north end of spoil disposal area. The lower stature grasses include blue sweetgrass and kneed foxtail.*

Photo 12: *Pūkio / swamp sedge, wīwī rush and exotic marsh bedstraw (with white flowers) surrounded by creeping bent and other exotic grasses at Wetland 9.*

Appendix 4: Freshwater Advice Memorandum

Boffa Miskell

Memorandum

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Attention:	Andrew Feierabend and Chris Thompson
Company:	Meridian Energy Limited
Date:	14 December 2023
From:	Dr Tanya Blakely, Associate Partner | Ecologist, Boffa Miskell Ltd
Message Ref:	Freshwater advice for managing construction effects associated with Manapōuri Lake Control Improvement Project
Project No:	BM220277D

Background

Meridian Energy Limited (Meridian) releases flows through the Manapōuri Lake Control (MLC) structure to the Lower Waiau River (LWR) in accordance with existing resource consent conditions. The types of flow released include minimum flows, lake and flood flows, recreational flows, and flushing flows. Each of these assists with managing nuisance periphyton growth and has benefits for river health. However, the current channel depth and alignment, and gravel accumulation in the Waiau Arm immediately upstream of the MLC, have been identified as the primary physical constraint affecting flow conveyance and reliability, particularly for flushing flows.

The aim of the Manapōuri Lake Control Improvement Project is to reduce these constraints by constructing a new, deeper channel adjacent and parallel to the Waiau Arm by removing accumulated gravel, and to provide for any necessary maintenance of the Waiau Arm channels. Following construction of the new, deeper channel, a more reliable conveyance of consented flows into the LWR is expected.

Scope

The scope of this memorandum is to provide freshwater ecology advice on managing construction effects of the Project's proposed excavation works on freshwater fauna potentially residing in freshwater habitats of channels on the northern bank of the Waiau Arm.

Limitations and assumptions

The advice provided in this memorandum is not intended to form an ecological impact assessment on the freshwater ecology or wetland ecology values potentially affected by the Proposal, as this has been covered by others, specifically:

- NIWA (2023). *Manapōuri Lake Control Flow Improvement Project. Assessment of Environmental Effects: Freshwater Ecology.* NIWA client report 2023293CH prepared for Meridian Energy Ltd. October 2023. Hereafter referred to as "**Freshwater Report**".
- Boffa Miskell Ltd (2023). Manapōuri Lake Control Improvement Project: Wetland Assessment Report. Prepared by Boffa Miskell Limited for Meridian Energy Limited. Hereafter referred to as "**Wetland Report**".

The advice in this memo is based on desktop information that we have been provided; Tanya Blakely has not been to the Project site.

Existing environment

The MLC is located approximately 9 km south-east of Lake Manapōuri and the Manapōuri township, at the confluence of the Waiau and Mararoa Rivers. The Project site is bound by the Waiau Arm and farmland to the north and west, the LWR and farmland to the south, and the Mararoa River to the east (Figure 1).

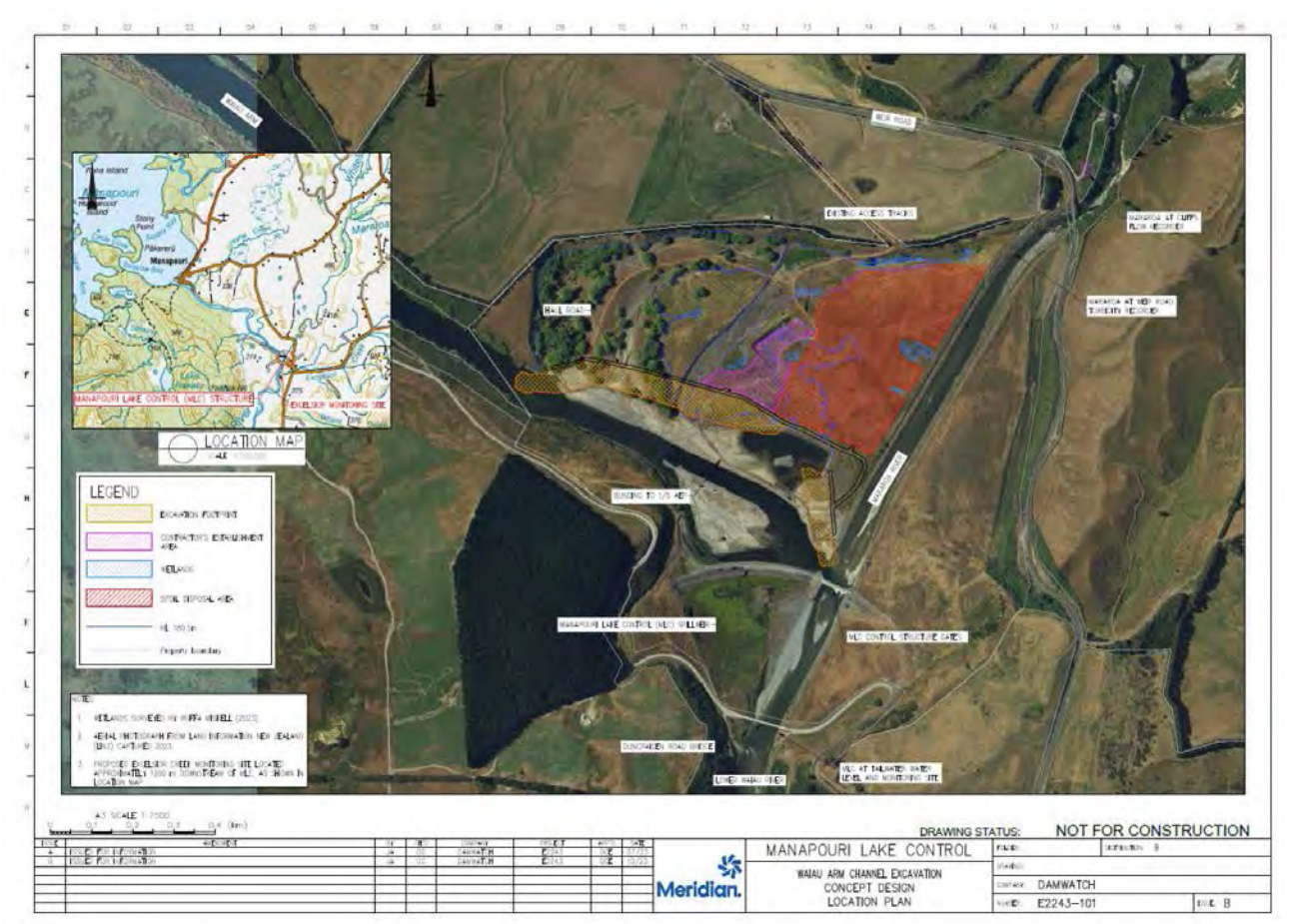


Figure 1. Location of the Project site showing the main project components.

Historic aerial imagery shows the Project site has been extensively modified during the 1970s to construct the Manapōuri Power Scheme, with surface flows across the Mararoa Delta now being diverted down the channelised Mararoa River (Figure 2). The historic channels of Mararoa River that can be seen within the Project site in aerial imagery (Figure 2, left image) no longer receive surface flows from Mararoa River today. Based on the Wetland Report (Boffa Miskell Ltd, 2023) and site photographs provided by the Project Team (Figure 3), the two eastern-most channels (hereafter referred to as Channels 1 & 2) appear to be ephemeral, while the western-most channel (hereafter referred to as Channel 3) appears to have permanent water along some of its length (Figure 3). Surface water within each of the channels fluctuates with the level of Lake Manapōuri; channels may be inundated at times of high lake levels, at other times Channels 1 & 2 may be completely dry. Due to the likely perennial nature of freshwater habitat in Channel 3, it is likely that this historical channel of Mararoa River provides habitat for freshwater fauna. However, site specific surveys have not be carried out.

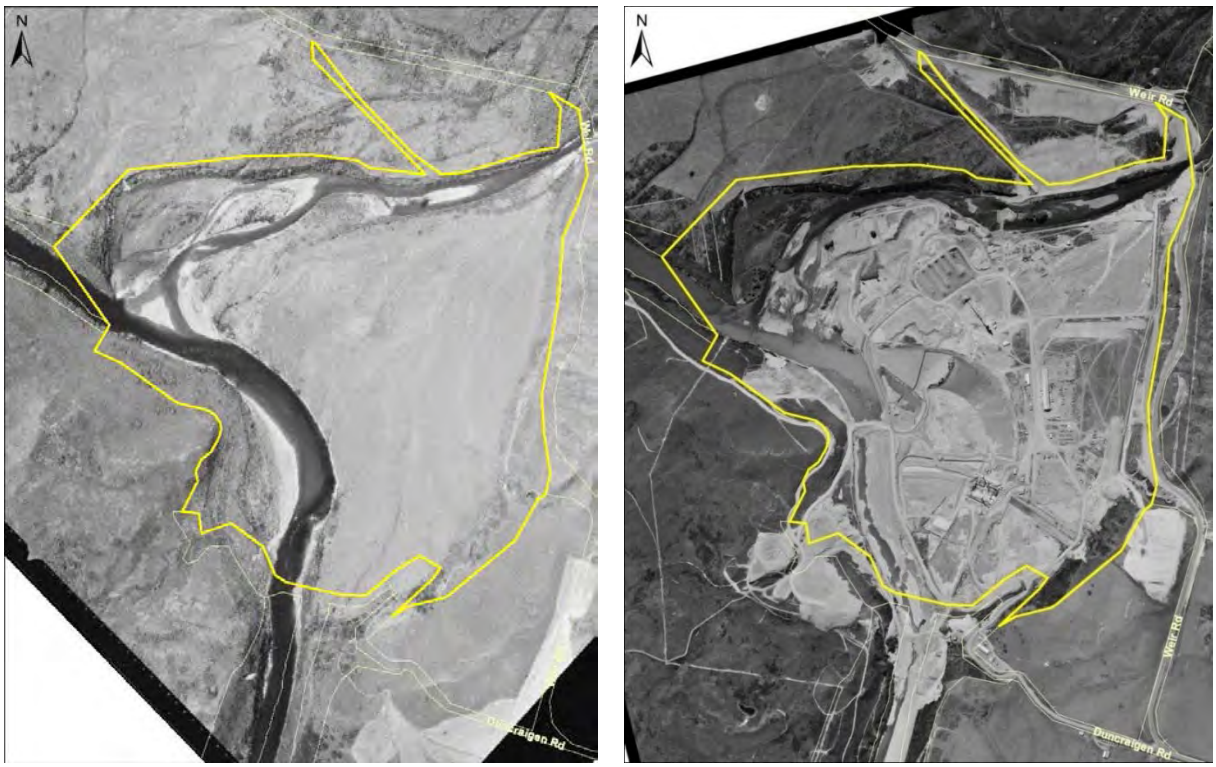
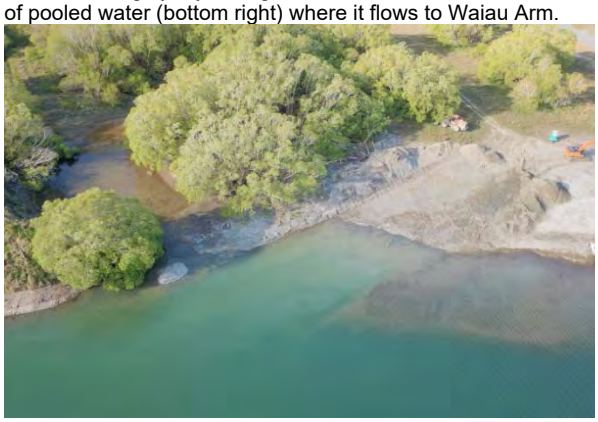


Figure 2. Aerial imagery of the Project site showing Mararoa River joining Waiau River in 1964 (left) and during construction of the MLC in 1974. sourced from http://retrolens.co.nz[1] and licensed by LINZ CC-BY 3.0.

Channel 1 largely dry during low lake levels, with a small area of pooled water (bottom right) where it flows to Waiau Arm.

Channel 2 dry during low lake levels.



Channel 3 with surface water present and connected to Waiau Arm channel.

The Project site during high lake levels, looking downstream with Channel 1 inundated in the foreground. Image provided by Nick Key of Meridian.

Figure 3: Historic channels of Mararoa River that no longer receive surface flows from the river. Eastern-most Channels 1 & 2 are likely ephemeral, Channel 3 may have permanent surface water present.

[1] https://retrolens.co.nz/map/#/1185007.5313702228/4934838.296502392/1186518.3570072947/4935851.087127085/2193/12

Based on information from previous studies (de Winton et al. 2022, Hoyle et al. 2023) the following native freshwater fauna are present at the Project site.

At least 15 native fish species are known from Waiau Arm and LWR (in the vicinity of but not necessarily within the Project site), including longfin eel, common bully, kanakana / lamprey, southern flathead galaxias and Gollum galaxias. Kākahi / freshwater mussels have also been found in the vicinity of the MLC. Salmonids (e.g., trout) are also present. Longfin eels and kākahi are listed as *At Risk – Declining*, kanakana / lamprey, and southern flathead and Gollum galaxias are listed as *Threatened – Nationally Vulnerable* (Dunn et al., 2018; Grainger et al., 2018). Common bully is not *Threatened*; brown trout is listed is *Introduced and Naturalised* (Dunn et al., 2018).

Proposed activity

The following provides a high-level summary of the proposed activity, taken from Damwatch (2023). *Proposed Manapōuri Lake Control Improvement Project. Construction Planning – Preferred Methodology (Draft).* Prepared for Meridian Energy Ltd. 15 October 2023.

- Approx. 85% of the excavation work will be completed 'in the dry' behind flood-protection bunds built up on the true-left riverbank.
- To achieve this, the following staging of excavation works has been proposed:
    - The highest areas on the new channel alignment will be excavated, with suitable excavated material used to construct dual-lane haul roads along the true left and bunding along the true right of the new channel alignment. The haul roads and bunds will be built up above expected river levels to prevent direct flow of surface water into the channel excavation area (Figure 4).
    - Culverts will be installed under the haul roads in Channels 1 and 2, to allow water to flood these channels on completion of the excavation works and removal of the bunds. Culverts will not be placed in Channel 3 as the road placed across this channel is exposed to the river and provides river-side flood protection / acts as a bund during excavation. The portion of the haul road across Channel 3 will be removed once the excavation works are completed (Figure 4).
    - Excavation of the new channel will be completed behind the bunds.
    - The final stages of construction of the new channel will require some works in flowing water, where the bunds are removed and the inlet and outlet to Waiau Arm are excavated.
- Dewatering (via pumps) of groundwater and river water seeping through the bunds and into the excavation site may occur if practicable, during the first 4 weeks or so of the excavation activity. This may include use of submersible pumps, placed in large-excavated sumps in Channels 1 and 2 and north of the excavation area. It is likely that an impermeable geomembrane lining will be placed on the riverside of the bunds to reduce seepage from the river into the excavation site.
- If de-watering is used, water will be pumped to seepage pond(s) on the north-eastern side of the Project site, to manage turbidity and avoid / minimise sediment discharge to Waiau Arm and the LWR.
- On completion of the excavation works to construct the new channel, the bund materials will be spread across the existing riverbanks and the bund across Channel 3 will be removed to reinstate hydrological connection with Waiau Arm (Figure 5).
- The excavation work will be completed by excavators working above prevailing water levels. As much excavation as possible will be completed by standard-arm excavators, but long-reach

excavators will be required for the deepest sections of the channel excavation, including the channel inlet and outlet excavation completed from temporary bunds in the Waiau Arm.

- Works are proposed to be undertaken between January and September, and are estimated to take approx. 4-5 months, in total, to complete.
- Construction of the new channel is anticipated to take 15 weeks, with a further 2 weeks for site rehabilitation. There will be no hydrological or ecological connectivity between the channels and Waiau Arm during the construction / excavation of the new channel (i.e., a period of approx. 15 weeks, between January and September).
- Hydrological and ecological connectivity will be reinstated on completion of the works (approx. 19 weeks after site establishment).

Figure 4. A haul road (black) and bund (orange) are first established to manage sedimentation effects during excavation of the new channel. Culverts will be installed in Channels 1 & 2 but not in Channel 3. Channels within the Project site are labelled 1, 2 and 3.

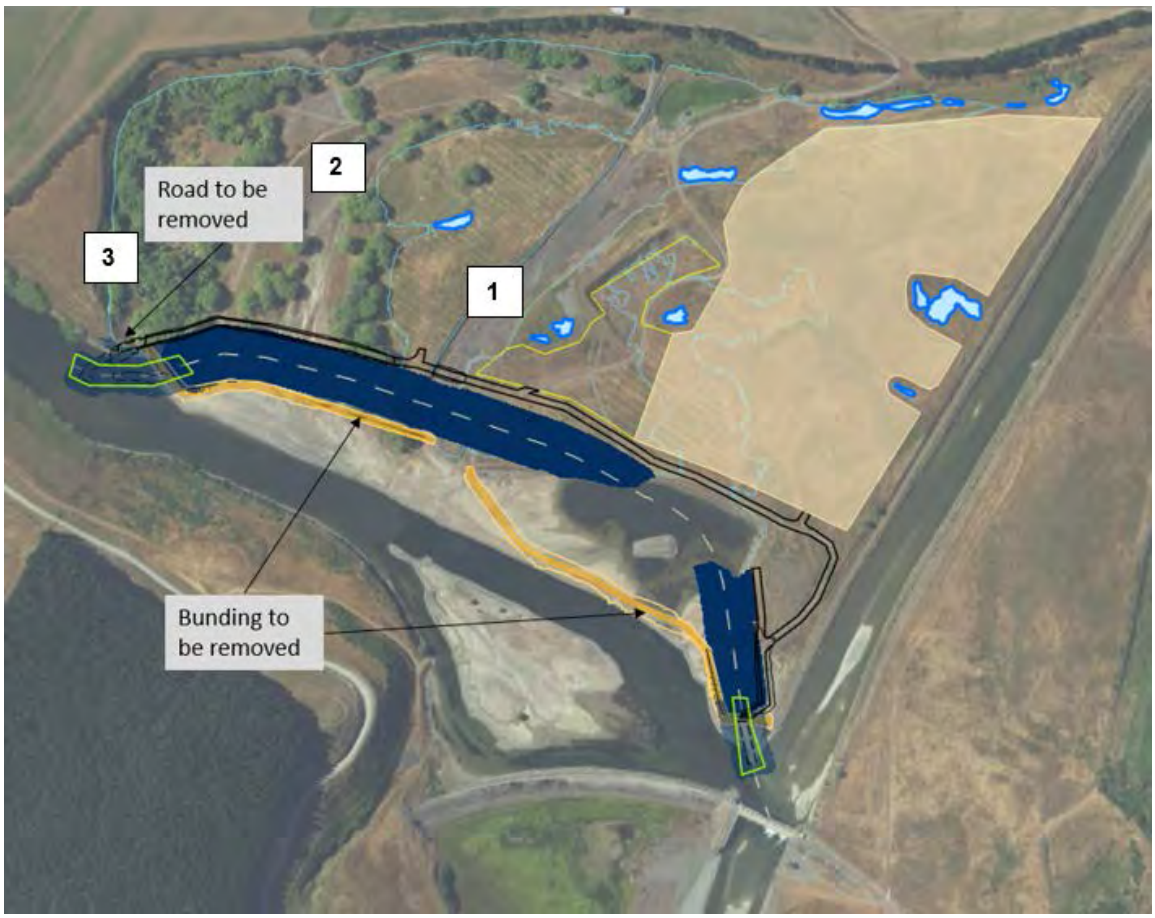


Figure 5. Excavation of the new channel (dark blue) and the inlet and outlet (light blue with green) tying in with Waiau Arm, construction bunds (orange), and permanent haul road (black). Dashed black lines indicate temporary (construction only) haul roads (from Damwatch, 2023). Channels within the Project site are labelled 1, 2 and 3.

Potential effects on freshwater fauna

This section focuses on potential effects of the proposed construction (e.g., excavation of the new channel, creation and use of bund and haul road during construction) on freshwater fauna residing in Channel 3 (and possibly Channels 1 & 2 when surface water is present).

The construction of the bund and haul road will enable excavation of the new channel. Much of this excavation work will be carried out in the dry. However, the bund and haul road will cross each of the three channels and if any surface water is present (likely in Channel 3, possible in Channels 1 & 2) there is the risk of disturbance, injury and mortality of resident freshwater fauna.

In addition, culverts will be installed under the haul road in Channels 1 & 2 but with the bund in place during construction there will not be any hydrological or ecological connection between these channels and Waiau Arm for a period of approx. 15 weeks between January and September. Culverts will not be placed in Channel 3 as the western-most end of the haul road will be removed during construction of the inlet, which (after site rehabilitation) will reinstate hydrological and ecological connection between Channel 3 and Waiau Arm. See Figure 4 and Figure 5 for further information of this staging.

As such, the two ecological effects on freshwater fauna to be considered are:

- Risk of disturbance, injury and mortality to resident freshwater fauna.
- Temporary (up to 15 weeks) loss of ecological connectivity between the channels and Waiau Arm.

Other potential effects on freshwater ecology have been considered in the Freshwater Report and are not discussed here.

Disturbance, injury and mortality of freshwater fauna

The proposed excavation works to complete the new channel will require installing a haul road across Channels 1, 2 & 3. As discussed above, Channel 3 likely has surface water present much of the time, while Channels 1 & 2 are often dry (except during high lake levels).

As discussed above, and detailed in the Freshwater Report, it's likely that Channel 3 provides habitat suitable for freshwater fauna, while Channels 1 & 2 are less likely to as these channels are assumed to be dry for extended periods during lower lake levels. Numerous freshwater fish and kākahi are known from freshwater habitats in the vicinity, but not necessarily within) the Project site.

There is risk of disturbance, injury and mortality through crushing or burying of fish and other freshwater fauna that reside in Channel 3 when material to form the temporary haul road is laid down across the channel. Similarly, there is risk of crushing or burying fish and other fauna that are present in surface water (if present) in Channels 1 & 2 when the culverts are installed and permanent haul road is laid down across the channels.

Recommendation:

- To avoid disturbance, injury, or mortality to freshwater fauna during the installation of the haul road and culverts in the channels, a suitably qualified and experienced freshwater ecologist must develop and implement a Freshwater Fauna Management Plan. This plan shall include:
    - Measures to avoid and minimise effects on freshwater fauna in areas where surface water is present at the time of construction works.
    - To avoid or minimise impacts on kākahi, if present, a survey for this species shall be undertaken prior to works commencing. The findings of this survey will inform the appropriate avoidance or minimisation measures, such as kākahi re-location, if kākahi are present in low densities and there is suitable alternative habitat nearby, and these management measures will be included in the Freshwater Fauna Management Plan.
    - Capturing and relocating fish and other fauna from the Channels both within the footprint of the haul road and from any connected freshwater habitat upstream of the work footprint immediately prior to construction works.
    - Advice around timing construction works to occur outside of critical periods, where practicable, as noted in the Freshwater Report.
    - Methods shall follow national guidelines (Ministry for the Environment, 2021) and as advised by a suitably qualified freshwater ecologist experienced in construction projects.

Temporary loss of ecological connectivity

As discussed above, aerial imagery and information provided by the Freshwater Report and Wetland Report suggest that Channel 3 is connected via surface water flows to Waiau Arm. This hydrological connection also provides ecological connection for freshwater fish to move between freshwater habitat in Channel 3 and Waiau Arm. The placement of the temporary haul road across Channel 3 will impede potential for movement of freshwater fish between Channel 3 and Waiau Arm, for a period of up to 15 weeks.

The species and abundances of the fish community within Channel 3 is unknown, as fish surveys have not been carried out in this freshwater habitat. It is plausible that freshwater fish, such as longfin eel and common bully, will be present.

The temporary haul road across Channel 3 will be removed when the new channel inlet is cut and the outlet of Channel 3 will be recontoured to reinstate the hydrological and ecological connectivity between Channel 3 and Waiau Arm. With the above recommendation in place to capture and relocate fish and other fauna from the Channel 3 both within the footprint of the haul road and from any connected freshwater habitat upstream of the work footprint immediately prior to construction works, and based on the assumption that Channel 3

likely supports low diversity and numbers of fish species, it is expected that the temporary loss of ecological connectivity will not be of ecological concern.

Channels 1 & 2 are unlikely to support freshwater fish as they are generally dry, so the temporary loss of hydrological and ecological connection is not expected to be of ecological concern. Upon completion of the channel excavation works, the bund alongside Waiau Arm will be removed, with material spread across the existing riverbanks; the haul road will remain in place and the culverts placed in Channels 1 & 2 during its construction will reinstate the hydrological connection between Channels 1 & 2 and Waiau Arm.

Recommendations:

- To avoid or minimise ecological effects due to temporary loss of hydrological and ecological connection between Channel 3 and Waiau Arm, capture and relocation of freshwater fish present within connected freshwater habitat upstream of the work footprint shall be carried out immediately prior to construction works and in accordance with the Freshwater Fauna Management Plan.

- A suitably qualified freshwater ecologist with experience in construction projects and fish passage shall provide advice on the site rehabilitation methodology to ensure fish passage between Channel 3 and Waiau Arm is reinstated on completion of the Project.

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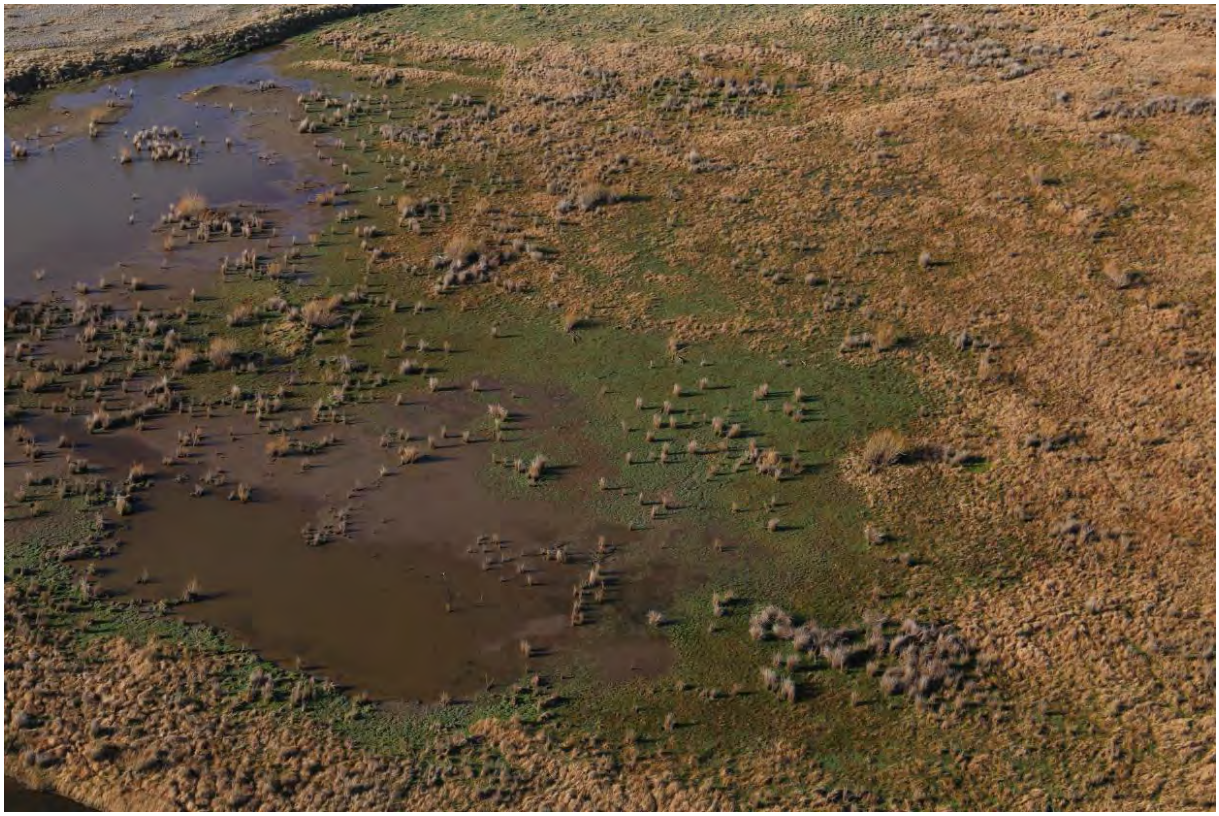
Appendix 5: Photographs of Wetlands Downstream of the MLC



Photos 13-14: *Mararoa Weir Wetland*

Photos 15-16: *Tower Peak Terrace Toe Wetland*

Photos 17-18: *North of Redcliff Wetland*

Photos 19-20: *Rakatu Riparian Wetland*

Photo 21-22: *Opposite Redcliff Creek Wetland*

Photos 23-24: *Redcliff Side Braid Wetland*

Photos 25-26: *Jericho Road Island Wetland*

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About Boffa Miskell

Boffa Miskell is a leading New Zealand professional services consultancy with offices in Whangarei, Auckland, Hamilton, Tauranga, Wellington, Nelson, Christchurch, Dunedin, and Queenstown. We work with a wide range of local and international private and public sector clients in the areas of planning, urban design, landscape architecture, landscape planning, ecology, biosecurity, cultural heritage, graphics and mapping. Over the past four decades we have built a reputation for professionalism, innovation and excellence. During this time we have been associated with a significant number of projects that have shaped New Zealand's environment.

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