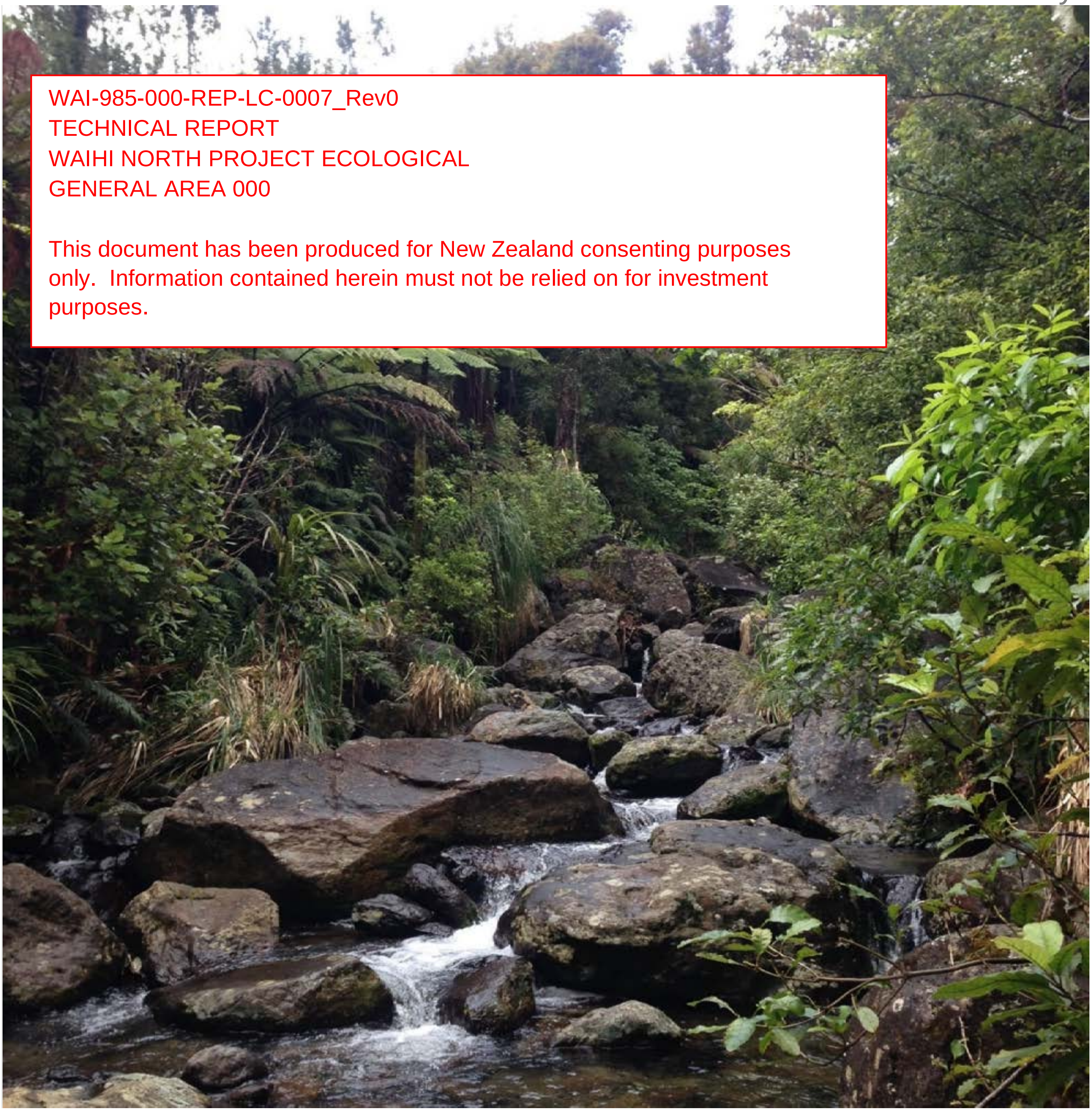
Boffa Miskell

Waihi North Project: Freshwater Ecological Assessment

Prepared for OceanaGold (NZ) Ltd

26 February 2025



WAI-985-000-REP-LC-0007_Rev0
TECHNICAL REPORT
WAIHI NORTH PROJECT ECOLOGICAL
GENERAL AREA 000

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Document Quality Assurance

Bibliographic reference for citation:
Boffa Miskell Limited 2025. *Waihi North Project: Freshwater Ecological Assessment:* Report prepared by Boffa Miskell Limited for OceanaGold (NZ) Ltd.
OceanaGold Document reference: WAI-985-000-REP-LC-0007 Rev C.1

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Status: FINAL	Revision C.1	Issue date: 26 February 2025

Template revision: 20230505 0000

File ref: Boffa Miskell2023 - Waihi North Project – Freshwater Ecological Assessment_20241002.docx

Executive Summary

The Waihi North Project comprises several components:

- A new Wharekirauponga Underground Mine (WUG), located approximately 11 km north-west of the township of Waihi under the Coromandel Forest Park;
- Site infrastructure supporting the WUG will be located on farmland located at the end of Willows Road;
- A services trench, located between Willows Road and Surface Facilities Area at Processing and Water Treatment Plants;
- The mining of a new Gladstone Open Pit (GOP) near the existing Processing Plant;
- A new tailings storage facility to the east of existing TSF1A, called TSF3;
- A new rock stockpile area (the Northern Rock Stack) located to the north of and adjacent to the existing TSF2;
- Upgrading of the existing Processing Plant and Water Treatment Plant (WTP).
- Reconsenting of the treated water discharge to the Ohinemuri River.

This report describes the site context, ecological survey, assessment methods, ecological values and significance assessment, and the effects of the WNP on wetland and freshwater ecological values.

Assessments of wetland and freshwater ecological values were undertaken at Willows Road Farm, along the Services Trench, the Gladstone Open Pit, TSF3 and Northern Rock Stack locations. Existing long-term monitoring data was used to inform the assessment of water quality and ecological values of the Ohinemuri River.

Natural Inland Wetland Ecological Values

Wetlands were assessed against the definitions and policies of the National Policy Statement for Freshwater Management and the National Environmental Standards for Freshwater. A single wetland (Mataura wetland) was identified at Willows Road Farm, which although heavily utilised and grazed, was assessed as having **Moderate** ecological values due to the presence of swamp maire. Other gully features at the Willows Road Farm site were excluded as natural wetlands.

A rehabilitated Gladstone wetland was assessed as a natural wetland with Moderate ecological values downslope of the proposed Gladstone Open Pit. An assessment of hydrology of the wetland suggests that the wetland has been formed as a result of the formation of a farm track and associated culvert. A headwater gully draining into the Gladstone wetland did not meet the definition of a natural wetland.

A former constructed silt pond within the footprint of the proposed northern rock stack was excluded as a natural wetland as it has been constructed by artificial means.

Freshwater Ecological Values

The freshwater ecological values across the WNP varied from low to high amongst the variety of stream types, and the history and current catchment land use.

The freshwater habitats surveyed within the Wharekirauponga Stream and its tributaries are of **Very High** ecological value. All habitats are classified as significant, providing habitat and migratory pathways to a number of Threatened and At-Risk native fish species (WRC 2016).

A warm spring (Ca. 19-20ºC) emerges from the ground some 5 m from the true right bank of the main stem of the Wharekirauponga Stream between Tributary R and the Edmonds Stream tributaries. The warm spring has a weak geothermal chemical signature and the biological communities do not strongly reflect a typical geothermal ecosystem. The biological communities have some distinguishing features but do not result in a unique flora and fauna community. Therefore, we have assessed the ecological value of the warm spring as **Low.**

The Waiharakeke Stream catchment has good instream habitat quality and quantity consisting of an array of different habitats, including, riffles, runs, pools, undercut banks and coarse woody debris. The streams were in a natural state with no modification. The ecological values of the Waiharakeke Stream are assessed as **Very High.**

At Willows Road Farm the Mataura Stream, a tributary of the Ohinemuri River, and draining from the Coromandel Forest Park has **High** ecological values, while three small tributary streams were subject to intense grazing around their respective catchments and have **Moderate** ecological values.

The headwater gully at the location of the proposed Gladstone Open Pit is an intermittent watercourse that periodically flows into the Gladstone wetland. Ecological values of this headwater gully are assessed as **Moderate**. The ecological values of the Gladstone wetland area also assessed as **Moderate**.

The Ruahorehore Stream in the area of the proposed TSF3 originates from tributaries in the Significant Natural Area (SNA) and is fed downstream by a series of artificial drainage channels. Ecological values of the upper Ruahorehore Stream Tributaries are **High**, with the presence of native fish and kōura. The values of the upper Ruahorehore Stream outside of the footprint, are **Low-Moderate**, while values are **Low** in the lower Ruahorehore Stream.

A small tributary (TB1) of the Ohinemuri River occurs at the location of the proposed northern rock stack. This stream is entrenched within a rehabilitated riparian vegetation and has **Moderate** ecological values.

The water quality and ecological values of the Ohinemuri River have remained **Moderate** throughout the continuing operations of the OceanaGold Waihi operations (and antecedent owners) since the re-opening in the 1980s. Discharges to the river are subject to instream water quality limits that have maintained ecological values over that time. The Ohinemuri River is habitat for a range of native fish and is an important introduced trout fishery.

Effects of WNP

A summary of the ecological values and effects of WNP are summarised below:

Feature	Ecological values	Effect	Magnitude of effect	Effects management	Level of effect with management
Wharekirauponga Stream and Tributary Streams					
Wharekirauponga Stream	Very High	No effect	Nil	Not applicable	No effect
Wharekirauponga Tributary Streams	Very High	No effect	Nil	Not applicable	No effect
Warm Spring	Low	Total loss of warm spring	Moderate	Offset with protection and enhancement of head gully and spring features at Tributary 3.	Very Low
Waiharakeke Stream catchment					
Waiharakeke Stream	Very High	No effect	Nil	Not applicable	No effect
Willows Road Farm					
Tributary 2	Moderate	Reclamation of 558 m of stream habitat	High	Offset ecological values with stream enhancement (tributary 1 and tributary 3) and rehabilitation following removal of rock stack. Reinstatement of stream after removal of rock stack.	Initially High Improved to Very Low with positive outcome.
		Instream works	Low	Aquatic fauna salvage	Very low
		Reduced aquatic connectivity	Low	Offset with stream enhancement	Very low
Mataura Stream	High	Earthworks and sediment discharge	Low	Settlement and treatment prior to discharge	Low
	High	Contaminant water management	Low	Treatment at WTP	Low
Gladstone Open Pit					
Headwater gully	Moderate	Loss of 47 m of intermittent stream length (~47 m^2)	High	Offset with stream enhancement	No loss of watercourse extent or

					ecological values. Low
		Loss of 0.14 ha of riparian vegetation	Moderate	Offset with riparian enhancement	Low
		Reduced aquatic connectivity	Very Low	Offset with riparian enhancement	Very Low
		Sediment intrusions	Low	Settlement and treatment prior to discharge	Low
Gladstone wetland	Moderate	Sediment intrusions Minimal hydrological variation	Negligible Low	Settlement and treatment prior to discharge	Negligible Low
Overall	Moderate	Various	Negligible to High		
Northern Rock Stack					
TB1	Moderate	Diversion of 1,389 m length of stream	Low	Creation of watercourse (in part) Aquatic fauna salvage and relocation Stream diversion that is ecologically functional.	No loss of ecological values; re-creation of watercourse extent (in part) Very low
		Reduced aquatic connectivity	Low	Offset through diversion	Very low
		Sediment intrusion	Low	Settlement and treatment prior to discharge	Very low
Tailings Storage Facility (TSF3)					
Ruahorehore Stream	Low - High	Diversion of 2,118 m of stream length	Low	Creation of watercourse at least equal to loss of extent. Aquatic fauna salvage and relocation.	No loss of watercourse ecological values; re-creation of watercourse extent (in part) Low

				Stream diversion that is ecologically functional (in part)	
		Reduced aquatic connectivity	Low	Offset through stream diversion (in part)	Low
		Sediment intrusion	Low	Settlement and treatment prior to discharge	Low
Farm detention pond	Low	Loss of pond habitat	Negligible	Fish salvage and relocation	Negligible

Re-consenting the Water Treatment Plant Discharge

Annual monitoring of the Ohinemuri River downstream of the mining operations water treatment plant shows that ecological values have remained stable and persistent since operations at OceanaGold Waihi commenced. OGNZL continues to comply with the consent conditions by carrying out the monitoring and any repeat sampling and investigations required by the treated water discharge permit. We emphasise that throughout the operation's discharge monitoring of the Ohinemuri River, Oceana Gold Waihi continue to meet the required receiving water quality standards with no detriment or adverse effect to the ecological values of the Ohinemuri River.

There is no evidence that the discharge from the OceanaGold Waihi water treatment plant (WTP) to the Ohinemuri River has caused any detrimental effects to the ecological values of the Ohinemuri River, and the ecological values have been maintained as anticipated by the criteria as set out in the consent conditions. Accordingly, re-consenting the WTP with the same receiving water quality standards will not result in detrimental effects on the ecological values of the Ohinemuri River. Notwithstanding this, we have recommended additional consent conditions for monitoring attributes in the Ohinemuri River to better understand the condition of the river, and for the purpose of better informing the Waikato Regional Council's future implementation of the National Objectives Framework under the National Policy Statement for Freshwater Management.

Effects of WNP on freshwater values

The proposed WNP activities do not result in any permanent loss of streams or natural wetlands, and no loss of ecological values of watercourses. Streams are either replaced within a short timeframe (diversions) or returned and rehabilitated at a later date (Mataura Stream tributary 2). The outcome of the WNP will be an improvement upon those aquatic ecological values than currently present.

In total, a 4,112 m length of watercourses will be reclaimed by the WNP project. A total of at least 3,469 m of watercourse will be created (approximately 16% of loss of watercourse length), and ecological values of some 10,285m of watercourse will be enhanced through stream restoration.

The overall mitigation for the WNP is conceived as a wholly integrated mitigation ‘package’ that encompasses all aspects of mitigation and offset proposed for landscape and ecological enhancements. Importantly, it is conceived in a manner so that the ‘whole’ is vastly improved from just the ‘sum of its respective components’.

Accordingly, the effects of the WNP on aquatic ecological values are low, and the outcome of WNP delivers an overall net gain for aquatic ecological values.

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Appendices

GLOSSARY

The table below sets out the defined terms and acronyms.

Term	Meaning
Alimak	A proprietary mast climbing (rack and pinion) access system developed by Alimak Group AB (Sweden; https://alimak.com/new-equipment/) that has been adapted to facilitate bottom-up underground shaft construction.
ARD	Acoustic Recording Device
Average Return Interval	The average time period between rainfall or flow events that exceed a given magnitude.
Benthic	Of, relating to, or occurring at the bottom of a body of water.
Canopy	Tallest layer of the forest.
Catchment	An area of land bounded by natural features such as hills or mountains from which surface water flows into streams, rivers and wetlands.
CFP	Coromandel Forest Park
Collection Pond	A pond for the purpose of gathering and retaining run-off water until it is in a state suitable for discharging to the surrounding environment. This may include settlement, treatment, and interception/removal of hydrocarbons.
Construction Runoff	Any runoff, sediment laden or otherwise, that flows as a result of the construction related activities. Typically results from rain events.
Cryptic species	Species camouflaged and adapted for concealment in their habitat.
Construction works	Activities undertaken to construct the Project.
DOC	NZ Department of Conservation
DVG	Default Value Guideline
Earthworks	Excavation and/or placement of cleanfill to change the contour or level of a site or part of a site (HDC).
Ecological District (ED)	A particular geographical region that has a characteristic landscape and range of biological communities.
Edge effects	Changes in population or community structure that occur at the boundary between two different habitats.

Term	Meaning
EPT taxa	Macroinvertebrate metric made up of **E**phemeroptera (mayflies), **P**lecoptera (stoneflies) and **T**richoptera (caddisflies).
FAR	Fresh air raise providing fresh air to the mine ventilation system.
Fish IBI	The Fish Index of Biotic Integrity (IBI) is a measure of how intact the native fish community is within a stream reach or stream.
Fish passage	The movement of fish between the sea and any river, including upstream or downstream in that river.
FMU	Freshwater Management Unit
GOP	Gladstone Open Pit
GOP TSF	Gladstone Open Pit converted to a tailings storage facility following the end of mining
HDC	Hauraki District Council
HDP	Hauraki District Plan (2019)
LENZ	Land Environments of New Zealand
LINZ	The Government Land Information Service of New Zealand
LoM, LoMP	Life of Mine, Life of the Mine Plan
Macroinvertebrate	Macroinvertebrates are small organisms without backbones (e.g., insects, snails and worms) that are visible to the naked eye, of a size that will not pass through a 0.5 mm sieve.
Mitigation package	A collective term used in this report that includes all aspects of the 'mitigation hierarchy'.
MUG	OGNZL's existing Martha Underground Mine
NAF	Non-Acid Forming: Rock that does not contain elements which may oxidise (weather) to form water soluble compounds capable of forming an acid
Natural Wetland	A wetland (as defined in the RMA) that is not: (a) a wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore, an existing or former natural wetland); or (b) a geothermal wetland; or

Term	Meaning
	(c) any area of improved pasture that, at the commencement date, is dominated by (that is more than 50% of) exotic pasture species and is subject to temporary rain-derived water pooling
NBEA	Natural and Built Environment Act
NES	National Environmental Standard
NESF	National Environmental Standard for Freshwater
NOF	National Objectives Framework
NPSIB	National Policy Statement for Indigenous Biodiversity (Draft)
NPS-FM	National Policy Statement for Freshwater Management 2020
NRS	Northern Rock Stack
OBDA	Overburden Disposal Area
OGNZL	OceanaGold (New Zealand) Limited
Overland Flow Path	Routes that collect and convey rainwater. Typically, only flowing for the duration of a rain event.
PAF	Potentially Acid Forming: Rock that contains elements which may oxidise (weather) to form water soluble compounds capable of forming an acid.
Plant Access Tunnel	A decline connecting the OGNZL Waihi processing plant area with the dual tunnels commencing at ventilation shaft 1 on Willows Road Farm largely for the transportation of ore and rock to and from the WUG mine.
Paper road	HDC legal road reserve: a legally-recognised road that is undeveloped or partly formed, but provides public access to a particular area or feature. The paper road for the WNP refers to a corridor that ranges in size from approximately 15 m – 150 m wide within Coromandel Forest Park that is owned by the local authority (HDC).
Permanent river or stream	A continually flowing body of fresh water, excluding ephemeral streams, and includes a stream or modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and

Term	Meaning
	farm drainage canal except where it is a modified element of a natural drainage system).
Pier	Vertical support structure for a bridge.
Priority Ecological Site	Locations of Moderate, High or Very High Ecological Value and/or locations recommended for ecological mitigation.
Processing Plant	The plant and associated infrastructure required to extract the gold and silver from the ore
Project area	The area within the proposed project footprint, and immediate surrounds to the extent Project works extend beyond this footprint.
RAR	Return air raise exhausting ventilation air from the mine.
RECCE	RECCE plot methodology is the collection of vegetation data within a 20 x 20 m plot (Hurst & Allen, 2007).
Silt Pond	A pond for staging run off water from mine surface infrastructure areas for the purpose of intercepting hydrocarbons and allowing the settling of sediments prior to discharge to the local environment
RPS	Regional Policy Statement
Sediment control	Capturing sediment that has been eroded and entrained in overland flow before it enters the receiving environment.
Willows SFA	Surface Facilities Area located on farmland at the end of Willows Road to service the new Wharekirauponga Underground Mine.
Waihi SFA	Surface Facilities Area located at Baxter Road including the Processing Plant, the WTP, workshop and underground offices and facilities.
Significant Natural Area (SNA)	Areas of significant terrestrial indigenous vegetation or significant habitats of indigenous fauna located either on land or in freshwater environments identified in District Plans. SNAs are assessed using the criteria for determining significant indigenous vegetation and significant habitats of indigenous fauna contained in the Waikato Regional Policy Statement, and nationally recognised criteria. The sites are identified on the planning maps and are listed in the schedule at the end of Section 6.2 as Significant Natural Areas.

Term	Meaning
Site	A habitat assemblage within the Project area identified and assessed by the Project team.
SOE	State of the environment
Stormwater	Water that flows from impervious areas after the construction period.
Stream Ecological Valuation	A standardised stream ecological survey methodology of stream functionality that informs offset calculations.
Taxon	A type / group of animals (e.g. species). The plural is 'taxa'.
Terrigenous	Sediment derived from the erosion of rocks on land; that is, that are derived from terrestrial environments.
Terrestrial	Land-based (i.e. terrestrial vegetation, terrestrial fauna).
Torpor	Decreased physiological activity in an animal, usually by a reduced body temperature and metabolic rate.
Treatment wetland	Vegetated stormwater treatment device designed to remove a range of contaminants, providing superior water quality treatment to wet ponds with increased filtering and biological treatment performance.
Treeland	Treeland is defined as vegetation in which the cover of trees in the canopy is 20–80 percent, with tree cover exceeding that of any other growth form, and in which the trees form a discontinuous upper canopy above either a lower canopy of predominantly non-woody vegetation or bare ground.
Tributaries	Small 'feeder' streams that drain into larger streams and rivers. The catchments of these tributaries are known as sub-catchments.
True Left or True Right	The true left and true right banks of a stream or watercourse refers the left or right side of the stream when looking downstream, i.e. looking to where the water is flowing to.
TSF	Tailings Storage Facility
Turbidity	Turbidity is a measure of water clarity or murkiness of a waterbody.
WAA	Wildlife Act Authority
Watercourse	A natural or artificial channel through which water flows.

Term	Meaning
Wetland	Defined in s2(1) of the RMA to include *"…permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions".* See definition for 'natural wetland'.
Willows Access Tunnel	A decline connecting the WUG Surface Facilities Area with the dual tunnels commencing at Vent Raise 1.
Willows Portal	The access portal to the Willow Access tunnel from the WUG surface facilities, located at the end of Willows Road, Waihi.
Willows Road Farm	A farm property of 197 hectares located at the end of Willows Road, Waihi, on which surface infrastructure and a portal will be constructed in support of the Wharekirauponga Underground mine,
WRC	Waikato Regional Council
WRC RPS	Waikato Regional Council Regional Policy Statement
WNP	Waihi North Project
WTP	Water Treatment Plant
WUG	Wharekirauponga Underground Mine component of the WNP
WUG Portal	The portal to the ore handling tunnel from the OGNZL Waihi Processing Plant area to the bottom of Vent Raise 1 for connection to the dual tunnels to the orebody.

1.0 Introduction

1.1.1 Background

The current Waihi life of mine plan (LoMP) including Project Martha, is to complete production by the end of 2030. Study work conducted between 2016 and 2020 identified opportunities to expand the Waihi operation with one new open pit, Gladstone Open Pit (GOP), and one new underground development (Wharekirauponga Underground Mine or WUG).

OceanaGold New Zealand Limited (OGNZL) has engaged Boffa Miskell Limited (BML) to prepare an Assessment of Ecological Effects for the proposed Waihi North Project (WNP, the Project). This report is provided to inform the preparation of the Assessment of Environmental Effects (AEE, Mitchell Daysh 2025), and further project details are contained therein.

The WNP comprises several elements, including:

- a new underground mine and associated facilities (Wharekirauponga Underground Mine or WUG);
- a new services trench between the WUG and the processing plant;
- a new open pit (Gladstone Open Pit, GOP);
- a new tailings storage facility (TSF3);
- a new rock stack (the Northern Rock Stack, NRS);
- upgrades to the existing Waihi Processing Plant and Water Treatment Plant (WTP); and
- Reconsenting of the existing treated water discharge to the Ohinemuri River.

BML has worked with OGNZL and its consultant team to provide detailed baseline information about wetland and freshwater ecological values that may be affected by the project, assess the effects of the project on these values and suggest methods for avoiding, where practicable, and minimising impacts on these values throughout the preliminary design process for the project.

1.1.2 Approach

This report describes the site context, ecological survey, assessment methods, ecological values and significance assessment, and the effects of the WNP on the wetland and freshwater ecological values.

Our approach utilises the Environment Institute of Australia and New Zealand (EIANZ) impact assessment guidelines (EIANZ 2018) approach to assess ecological values and significance, and to assess the magnitude of the project’s effects on those ecological values. Criteria for assessing significance also included those contained the Waikato Regional Policy Statement (RPS) (WRC, 2016).

Our report describes the assessment of the environmental effects of the project on the:

- Wetland and freshwater ecological values of the Wharekirauponga underground mine and associated facilities;
- Wetland and freshwater ecological values of the Services Trench;

- The wetland and freshwater ecological values of the GOP; and
- The wetland and freshwater ecological values of TSF3; and
- The wetland and freshwater ecological values of the NRS; and
- The freshwater ecological values of the reconsenting of the Processing Plant and WTP.

We present each of these components within separate chapters associated with the main project activities. Terrestrial ecological values and effects assessment for the GOP, TSF3, NRS, and Processing Plant are provided in Bioresearches (2021), and for the WUG and associated infrastructure in Boffa Miskell (2022).

The WNP takes an overall 'Nature Positive' approach to impact management whereby all potential significant impacts on biodiversity are mitigated / compensated / offset (as appropriate) to a level that a Net Gain is the expected outcome.

1.1.3 Report Structure

This report is set out as follows:

Section 1	Presents an overview of the project and our assessment approach.
Section 2	Describes the project location, detailed project description and site context.
Section 3	Provides a brief overview of the Ohinemuri River catchment.
Section 4	Outlines existing ecological enhancements.
Section 5	Provides an overview of relevant statutory matters.
Section 6	Describes general methodology used across all parts of the project.
Sections 7–11	Describes the ecological survey and analysis methodology and values assessment for the Wharekirauponga, GOP, TSF3, NRS and Processing Plant elements, respectively.
Section 12	Outlines the significance of indigenous biodiversity.
Section 13	Details the water quality and standards of the Ohinemuri River.
Sections 14-18	Describes the effects of WNP on ecological values of Wharekirauponga, GOP, TSF3, NRS and Processing Plant elements, respectively.
Section 19	Describes the treated water discharge.
Section 20	Describes the water quality criteria for the Ohinemuri River
Section 22	Describes the treated water pipeline and outfall.
Section 22	Describes the management of effects.
Section 23	Describes the additional positive enhancements.
Section 24	Describes proposed monitoring.
Section 25	Conclusion.

2.0 Project Location and Description

2.1.1 Project Location

The OceanaGold Waihi gold mines are located within and adjacent to the Waihi township, near the east coast of the North Island of New Zealand. The site currently consists of the Martha Open Pit and the Correnso, Slevin, Favona, Trio and Martha Underground mines.

The proposed footprint of the surface works for the Waihi North Project is set across five areas of works as listed in section 2.2 below and shown in Figure 1.

The land surrounding the current surface mining operations (mainly zoned Martha Mineral Zone in the Hauraki District Plan) is predominantly rural, except for the Martha Pit which is surrounded by residential, low-density residential and town centre areas. No activities in or around Martha Pit are proposed as part of the WNP. Proposed surface works as part of WNP are largely either located within the existing Martha Mineral Zone or within the Rural Zone (refer the Hauraki District Plan).

The existing mining site is located within the Ohinemuri River Catchment, a tributary of the Waihou River and within the Waihi Ecological District (ED). Major tributaries of the Ohinemuri River include the Ruahorehore Stream, Mangatoetoe Stream and Mataura Stream, a number of smaller waterbodies draining into the river in the vicinity of Waihi; as well as the Waitawheta and Waitekauri Rivers lower in the catchment. A summary account of the landuse and history of the Ohinemuri River and its environment is provided in section 3.

The WUG is located in Coromandel Forest Park (CFP) (administered by the Department of Conservation, DOC), within the Mataura, Ramarama, Waiharakeke and Wharekirauponga catchments. The WUG is located south of Otahu Ecological area, the only Ecological Area in the Waihi Ecological District. The portal entrance, Surface Facilities Area, services corridor, and the tunnel to processing plant are located in predominantly rural farmland north of Waihi township.

2.1.2 Project Description

The WNP provides for two mining operations, provides sufficient surplus rock storage and tailings disposal areas and sets appropriate closure criteria. We understand that re-siting of some of the existing underground infrastructure is required due to the proximity of the proposed GOP to the existing Favona portal and surge stockpile. Establishment of a new Surface Facilities Area near the Willows Road portal will be required to support the tunnelling and subsequent mining at Wharekirauponga. A new portal for ore delivery and rock return will be constructed close to the Processing Plant for servicing the WUG via a tunnel extension to meet at the Willows Road vent raise 1 (underground).

The Waihi North Project comprises several components (Figure 1):

- A new underground mine, Wharekirauponga, located approximately 11 km north-west of the township of Waihi. Site infrastructure supporting the mine will be located on OGNZL owned farmland located at the end of Willows Road, with only minimal surface features, in the form of fenced vent raises;
- A new Services Trench connecting the Willows Road Farm to the existing Waihi Plant to carry power, fibre optic cables and treated / potable and recycled water.

- The mining of a new open pit near the existing Processing Plant, centred over Gladstone Hill, the Gladstone Open Pit (GOP). This pit will be converted to a tailings storage facility on completion of mining;
- A new tailings storage facility to the east of existing TSF1A, called TSF3;
- New rock stack (NRS) at the Northern Stockpile area adjacent to the existing TSF2; and
- Changes to the layout of the existing Processing Plant to enable ore processing up to 2.25 million tonnes per annum (MTPA), up from 1.25 MTPA currently.

The project requires upgrades to the existing WTP to manage the significant increase in water treatment demand. As such, the existing WTP will be expanded by adding new treatment streams, and the current discharge permit will be re-applied for with the same consent conditions. No change to the discharge limits of treated water to the Ohinemuri River is anticipated.

2.1.3 Ecological Context

The WNP site is located within the Ohinemuri River, Otahu River and Ramarama Stream catchments. The Ohinemuri River is a tributary of the Waihou River and within the Waihi Ecological District (ED). As outlined above, major tributaries of the Ohinemuri River include the Mataura River, Ruahorehore Stream and Mangatoetoe Stream. The Ramarama Stream discharges to the sea north of Whiritoa. Major tributaries to the Otahu River include the Waiharakeke and the Wharekirauponga Streams and their minor tributaries. The Otahu River discharges to the sea south of Whangamata.

Waihi Ecological District includes the land from Whangamata south to Waihi Beach and encompasses the entire project area. With the exception of CFP land, much of the vegetation in Waihi ED has been modified through farming and urban development. Native forest within Waihi ED comprises tawa-dominated forest with emergent northern rata, rimu, totara, miro, pukatea and kauri (Kessels & Associates, 2010).

The land surrounding the existing mine operations, excluding the Martha Pit, is generally open with predominantly grazed pasture with some areas of plantation pine, native vegetation and low-density rural dwellings. The land is typically low-lying with some rolling hills and small ridges.

Large significant natural areas (SNAs) within the wider Waihi area include Ngatikoi Domain / Black Hill Reserve (SNA 165), located west of TSF2 and the Northern and Southern Fragment of SNA 166, both northeast of TSF2. The ecological values of these are described in Bioresearches (2021).

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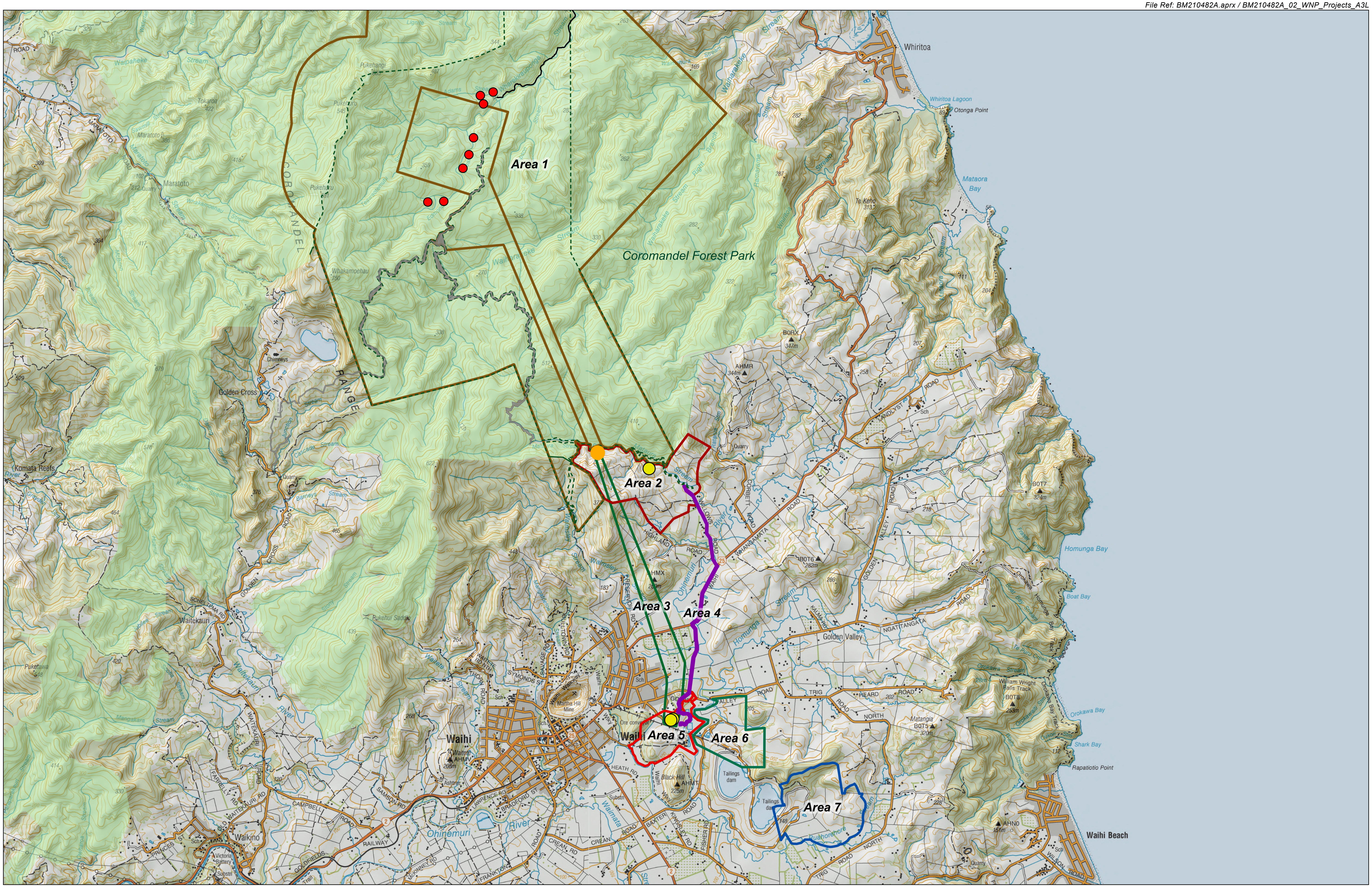

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Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Vent Raise 1
- Tunnel Portal
- Indicative Drill Site Locations
- Wharekirauponga Walk
- Area 1: Wharekirauponga Underground Mine
- Area 2: Willows Road Farm
- Area 3: WKP Underground Access Tunnel
- Area 4: Services Trench Corridor
- Area 5: Gladstone Open Pit
- Area 6: Northern Rock Stack
- Area 7: Tailings Storage Facility 3
- Coromandel Forest Park
- Paper Road
- Access Arrangement Area

WAIHI NORTH

WNP Projects

Date: 18 February 2025 | Revision: 4

Plan prepared for Oceana Gold by Boffa Miskell Limited

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Figure 1

3.0 The Ohinemuri River Catchment

3.1.1 Location

The Ohinemuri catchment is located in the Hauraki District of the Waikato Region with its headwaters originating in western hill-country, north-east of Waihi. The Ohinemuri River is approximately 28 km in length and flows in a westerly direction, draining steep hill country to the north (the southern end of the Coromandel Range) and to the south (northern end of the Kaimai Range). The river flows through the Karangahake Gorge and across floodplains to its confluence with the Waihou River near the township of Paeroa, and the Waihou River travels north to discharge into the Firth of Thames.

3.1.2 Land Use

WRC (2019) summarise the land use within the Ohinemuri River catchment. The Ohinemuri has a catchment area of 34,803 ha and the predominant land cover is dairying (34%), along with indigenous forest (30%) located primarily in the steeper areas of the catchment (Figure 2). Another 16% of the catchment is in livestock farming. Other land uses include fruit growing, lifestyle block, idle land, plant nurseries, poultry, saleyards, tourism, urban, vegetable and wetland, which in total amounts to some 5% of the total area of the catchment. The two main towns within the catchment are Paeroa and Waihi.

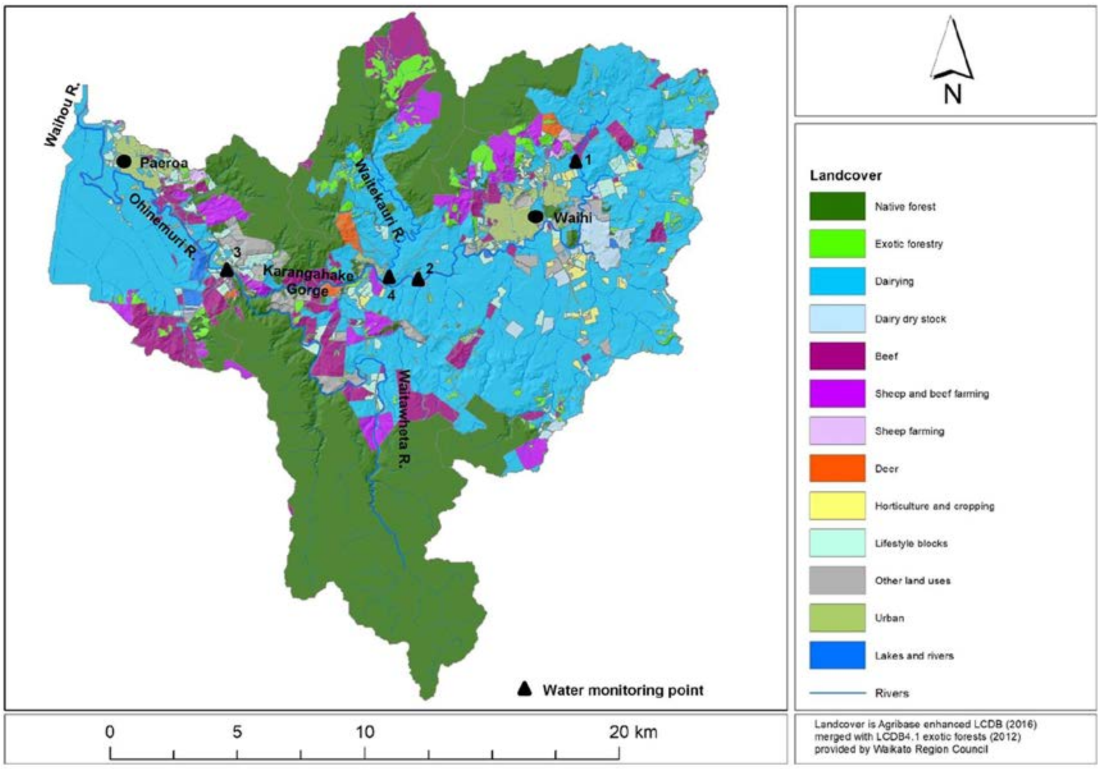

Figure 2: *Landcover within the Ohinemuri River catchment. Water monitoring points are the WRC and NIWA SOE programme. From WRC (2019).*

3.1.3 Overview of Catchment Water Quality

We discuss specific water quality in the vicinity of the OceanaGold operations in later sections of our report. However, WRC (2019) recently summarised the overall water quality of the Ohinemuri River and concluded that, for most water quality variables, the Ohinemuri River system can regulate contaminants to a satisfactory or excellent rating for human and ecological health (assessed against WRC water quality guidelines and standards).

The two notable exceptions where catchment pressures are regarded as exceeding the regulatory capacity of the main stem of the Ohinemuri catchment are concentrations of total nitrogen which are at unsatisfactory levels (out of the three monitoring sites along the main stem of the river), along with temperature requirements for fish spawning. With regard to heavy metals, WRC (2019) draws on the monitoring undertaken by OGNZL (summarised in BML 2018) that heavy metal concentrations are below resource consent compliance limits that are based on USEPA (1986) criteria.

The Ohinemuri River has improved considerably since the 1950s when it was essentially a 'dead' river with a heavy load of gold mining tailings dumped in the river. Indeed, the river downstream of the current operations was declared a sludge channel in the early 20th century by the government of the day.

3.1.4 Recreational Fishing (Trout)

The Ohinemuri River, its tributary the Waitawheta River and to a lesser extent the Waitekauri River tributary, are popular rivers for fishing. The Ohinemuri River is regarded as having excellent access and a good population of both rainbow and brown trout and the section through the Karangahake Gorge is the most popular and productive section of the river for trout fishing. Access to much of the Ohinemuri is relatively easy as State Highway (SH) 2 follows the river for much of its length.

In the 2014/15 National Angling Survey, angler days totalled 1030 for the Ohinemuri River system (comprising the combined results for the mainstem (700 +/- 240), Waitawheta Stream (320 +/- 80) and Waitekauri River (10 +/- 10) (Unwin 2016). However, angling days in the Ohinemuri River have declined by some 50% from the initial survey in 1994/95 (NIWA 1998), and Greenaway (2025) reports recent National Angler Survey (NAS) results that show that decline has continued in 2021/22.However, Greenaway (2025) goes on to report that the Ohinemuri River compares well with other waterways in the Fish & Game region and was the sixth most popular river fishery in the region in the 2014/15 season.

WRC (2019) suggest that this decline in angler days is most likely influenced by increasing water temperatures and for 7-8 months of the year this thermal barrier limits trout occupancy in the lower section of the river.

Earlier studies (Bioresearches 1982) suggested that the highest quality native fish habitat was present in the northern tributaries and headwaters of the Ohinemuri River. Of these tributaries the Mataura Stream and Waitekauri River were considered to provide the widest range and best quality habitat for all life stages of trout and probably played a major role in sustaining the mainstem of the Ohinemuri River trout fishery. In addition, the Ratarua, lower Walmsley and Waitete Streams all had suitable trout habitat. The Ohinemuri River provided an extensive area of trout habitat and juvenile trout were numerous in the middle and upper sections of the river. The tributaries of the Ohinemuri River are considered important trout spawning and nursery grounds.

In previous expert evidence, Daniel (2017) stated that the ‘Ohinemuri trout population crashes frequently and Sport Fly Fishing NZ stopped using the river for fly fishing competitions in 2013 due to a lack of fish. Fish and Game attempted to stock the Ohinemuri river with 500 tagged yearling trout in 2015 but despite extensive fishing no tagged fish were ever recovered indicating very low survival compared to normal recovery rate of 6.5%. After the exceptionally wet conditions and sustained high flows over the last two years competitions have resumed due to a recovery in the trout population.’ Daniel (2017) goes on to refer to the multiple stressors including extreme water temperatures, degraded water quality, migration barriers and degraded habitat that occur in the Ohinemuri River.

4.0 Existing Ecological Enhancements

Considerable planting has been undertaken across the Waihi site and surrounding areas by OGNZL (and the former Waihi Gold), with 455,400 plants planted between 1995-2016. Of these plants 206,541 were identified as 'riparian' plantings and a further 14,379 and 41,805 plants were identified as 'swamp' and 'gully' plantings respectively. These plantings totalled 35.31 ha of restoration plantings in and around the Waihi township.

The location of these plantings includes alongside the Ohinemuri River, TB1 Stream and Eastern Stream (both established as diversions and both now functioning watercourses) and several associated wetlands, and the lower reaches of the Ruahorehore Stream and tributaries (Figure 3). These plantings have improved the ecological value and function of these watercourses and wetlands.

We note that much of the riparian restoration planting (notably along the Ohinemuri River) was carried out to improve the stability of the banks, following observations of extensive erosion following removal of willows and other vegetation for catchment flood management purposes in the 1980s. These plantings have been important in reducing erosion and sediment intrusion into the river.

A portion of the stream habitat that is scheduled for removal has been previously restored by OGNZL to a high standard. The previous restoration work has been a major contributor to the ecological values that are described in our report, particularly as reviews of old satellite imagery shows that many of these habitats were degraded pastureland features and willow-dominated margins prior to restoration. In other circumstances, the restoration has made use of artificial features such as redundant silt ponds.

We note that no formal monitoring has been carried out to ascertain the specific benefits to stream or wetland function arising from the enhancements. As the activities were voluntary there was no regulatory requirement for monitoring the outcomes.

However, later in our report (section 20), we show that monitoring over the years has not shown detriment in the stream health of the Ohinemuri River. The extensive stream restoration works on the Ohinemuri River was aimed at stabilising the banks and to reduce the bank erosion and thus sediment entering the river along these reaches. Bank erosion has continued (and still does to this day) upstream and downstream of the mine site (and continues to contribute to the sediment in the river downstream, through and beyond the mine operations). Accordingly, whilst no specific monitoring of these actions has been carried out, evidence of a reduction in bank erosion through planting the riparian margin can clearly be observed.

The same is true of riparian planting of the Ruahorehore Stream. For the most part, riparian planting within the Ruahorehore Stream catchment has occurred on the true right bank alone (OGNZL do not own the left bank).

As a basic principle of stream restoration and enhancement, riparian planting can have multiple benefits, and all planting/enhancement should be designed for a specific purpose(s). Accordingly, the riparian planting of the Ohinemuri River was focused less on shading and more on bank stability (lower stature plants with good rooting/soil binding potential, and the plant types reflect that purpose). We note that the Ruahorehore Stream is a smaller watercourse (than the Ohinemuri River) and the broader benefits of riparian planting (e.g., shading) are more evident with a reduction in excessive growth of aquatic macrophytes, resulting in diversifying the available habitat.

These enhancements have been entirely voluntary by OGNZL and have not been undertaken as part of any regulatory or land purchase requirements.

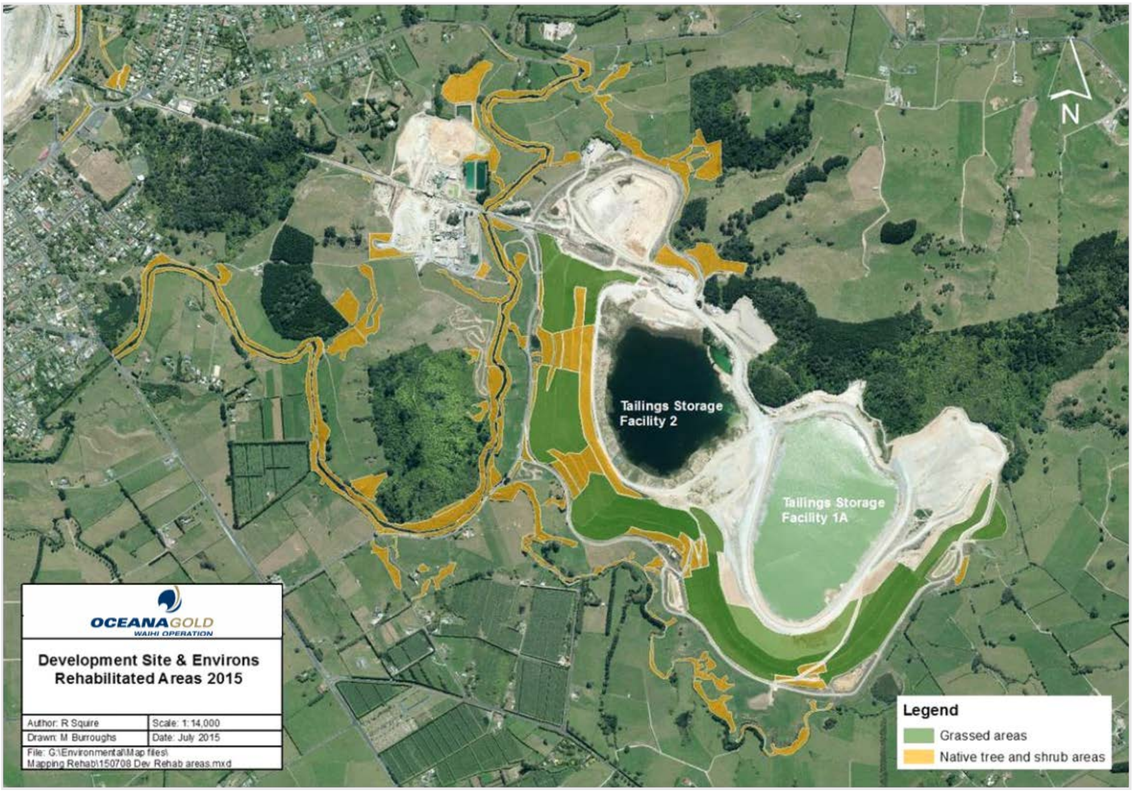

Figure 3: *Environmental enhancement carried out at OGNZL site 1995 – 2015.*

5.0 Statutory Definitions and Assessment Criteria

5.1.1 Introduction

In this section we comment on the relevant statutory definitions to be applied to ecological features of the WNP and appraise the criteria to be applied in assessing significant indigenous habitats of indigenous fauna. We emphasise that this section is not a statutory assessment. In this section we make reference to:

- National Policy Statement for Freshwater Management (NPS-FM)
- National Environment Standards for Freshwater (NESF)
- National Policy Statement for Indigenous Biodiversity (NPS-IB)

5.1.2 NPS-FM and NESF

5.1.3 Background

The National Policy Statement for Freshwater Management 2020 ('NPS-FM', New Zealand Government, 2020a) and the National Environmental Standard for Freshwater ('NESF', (New Zealand Government, 2020b) were released on 5 August 2020 and took effect from 3 September 2020. Amended versions of both the NPS-FM policy and NESF regulations came into effect in January 2024.

Both the policy and regulations include specific provisions related to natural wetlands and streams, as well as other freshwater-related activities. Here we provide a brief overview of the purpose and provisions of the NPS-FM and the NESF as they are relevant to the proposed Project activities.

5.1.4 National Policy Statement for Freshwater Management

Objectives

The NPS-FM directs Regional Councils to undertake a variety of policy inclusions or modifications to policy, as well as to undertake specific tasks. The NPS-FM also directs Councils to be satisfied that the 'Effects Management Hierarchy' is applied to the existing and potential values where appropriate and provided for in the policy and regulations.

The NPS-FM, the effects management hierarchy means, in respect of natural inland wetlands and rivers, an approach to managing the adverse effects of an activity on the extent or values of a wetland or river that requires:

(a) adverse effects are avoided where practicable; then

(b) where adverse effects cannot be avoided, they are minimised where practicable; then

(c) where adverse effects cannot be minimised, they are remedied where practicable; then

(d) where more than minor residual adverse effects cannot be avoided, minimised, or remedied, aquatic offsetting is provided where possible; then

(e) if aquatic offsetting of more than minor residual adverse effects is not possible, aquatic compensation is provided; then

(f) if aquatic compensation is not appropriate, the activity itself is avoided.

The application of the effects management hierarchy in this report is further discussed in section 6.6.

RMA and NPS-FM wetland definitions (s. 3.22)

The RMA definition states:

- Wetland includes permanently or intermittently wet areas, shallow water, and land margins that support a natural ecosystem of plants and animals that are adapted to wet condition.

The NPS-FM definition[1] states:

natural inland wetland means a wetland (as defined in the Act) that is not:

- in the coastal marine area; or
- a deliberately constructed wetland, other than a wetland constructed to offset impacts on, or to restore, an existing or former natural inland wetland; or
- a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body; or
- a geothermal wetland; or
- a wetland that:
  - o is within an area of pasture used for grazing; and
  - o has vegetation cover comprising more than 50% exotic pasture species (as identified in the *National List of Exotic Pasture Species* using the *Pasture Exclusion Assessment Methodology* (*see* clause 1.8)); unless
  - o the wetland is a location of a habitat of a threatened species identified under clause 3.8 of this National Policy Statement, in which case the exclusion in (e) does not apply.

- **threatened species** means any indigenous species of flora or fauna that:

  (a) relies on water bodies for at least part of its life cycle; and

  (b) meets the criteria for nationally critical, nationally endangered, or nationally vulnerable species in the *New Zealand Threat Classification System Manual* (*see* clause 1.8).

The NPS-FM requires that:

[1] NPS-FM, s3.21(1)

(1) Every regional council must include the following policy (or words to the same effect) in its regional plan(s):

"*The loss of extent of natural inland wetlands is avoided, their values are protected, and their restoration is promoted"* (with exceptions and subject to the effects management hierarchy).

The policy direction provides for some exceptions, including for the extraction of minerals and associated activities (cl 3.22(1)(e)).

NPS-FM Rivers (s3.24)

THE NPS-FM requires that:

(1) Every regional council must include the following policy (or words to the same effect) in its regional plan(s):

"The loss of river extent and values is avoided, unless the council is satisfied:

(a) that there is a functional need for the activity in that location; and

(b) the effects of the activity are managed by applying the effects management hierarchy."

National Objectives Framework

Subpart 2 of the NPS-FM requires certain attributes to be managed within a compulsory National Objectives Framework (NOF). The NOF requires that water quality is maintained or improved where degraded and sets national bottom lines and water quality attribute bands for a variety of parameters. The NPS-FM requires that Councils apply compulsory values to freshwater management units (FMUs) in their respective regions as part of the NOF (Subpart 2, 3.9(1)). Those compulsory values relevant to freshwater ecology are:

Ecosystem health refers to the extent to which a Freshwater Management Unit (FMU) or part of an FMU supports an ecosystem appropriate to the type of water body (for example, river, lake, wetland, or aquifer).

There are five biophysical components that contribute to freshwater ecosystem health, and it is necessary that all of them are managed. They are:

Water quality – the physical and chemical measures of the water, such as temperature, dissolved oxygen, pH, suspended sediment, nutrients and toxicants.

Water quantity – the extent and variability in the level or flow of water.

Habitat – the physical form, structure, and extent of the water body, its bed, banks and margins; its riparian vegetation; and its connections to the floodplain and to groundwater.

Aquatic life – the abundance and diversity of biota including microbes, invertebrates, plants, fish and birds

Ecological processes – the interactions among biota and their physical and chemical environment such as primary production, decomposition, nutrient cycling and trophic connectivity.

In a healthy freshwater ecosystem, all five biophysical components are suitable to sustain the indigenous aquatic life expected in the absence of human disturbance or alteration (before providing for other values).

Threatened species in the NOF refers to the extent to which an FMU or part of an FMU that supports a population of threatened species has the critical habitats and conditions necessary to support the presence, abundance, survival, and recovery of the threatened species. All the components of ecosystem health must be managed, as well as (if appropriate) specialised habitat or conditions needed for only part of the life cycle of the threatened species.

We note that WRC has identified FMUs in their regional plan but has not yet implemented the NOF by undertaking the necessary plan changes to develop water quality targets and timeframes for implementation, including for the Ohinemuri River. Notwithstanding this, in our values assessment we have given recognition to the attributes requiring limits on resource use (Appendix 2A of the NPS-FM) and attributes requiring action plans (Appendix 2B of the NPS-FM).

5.1.5 National Environmental Standards Freshwater

NESF regulations on natural wetlands

The NESF provides some specific regulations for natural wetland activities, notably:

53(1)(a) Earthworks within a natural inland wetland is a prohibited activity if it results, or is likely to result, in the complete or partial drainage of all or part of a natural inland wetland;

53(2)(a) The taking, use, damming, or diversion of water within a natural inland wetland is a prohibited activity if it results, or is likely to result, in the complete or partial drainage of all or part of a natural inland wetland;

54(a) vegetation clearance within, or within a 10 m setback from, a natural inland wetland

54(b) earthworks within, or within a 10 m setback from, a natural inland wetland

54(c) the taking, use, damming, or diversion of water within, or within a 100 m setback from, a natural inland wetland if—

- (i) there is a hydrological connection between the taking, use, damming, or diversion and the wetland; and
- (ii) the taking, use, damming, or diversion will change, or is likely to change, the water level range or hydrological function of the wetland:

54(d) the discharge of water into water within, or within a 100 m setback from, a natural inland wetland if—

- (iii) there is a hydrological connection between the discharge and the wetland; and
- (iv) the discharge will enter the wetland; and
- (v) the discharge will change, or is likely to change, the water level range or hydrological function of the wetland.

In addition, Regulations 38 - 51 identify specific circumstances where the above activities have a different activity status. In particular, 45D provides a discretionary status for all the above activities where the purpose is for mineral extraction and ancillary activities. However, 45D(6) notes that a resource consent for a discretionary activity under this regulation must not be granted unless the consent authority has first—

(a) satisfied itself that the extraction of the minerals will provide significant national or regional benefits; and

(b) satisfied itself that there is a functional need for the extraction of minerals and ancillary activities in that location; and

(c) applied the effects management hierarchy.

Regulation 55 specifies a number of general conditions on activities in and around natural inland wetlands for permitted activities.

NESF regulations on reclamation of rivers

Subpart 2 of the NESF provides that reclamation of the bed of any river is a discretionary activity.

NESF regulations on fish passage

Subpart 3 of the NESF provides for the passage of fish affected by structures, with specific requirements for culverts, weirs, flap gates, dams and fords (Regs. 58-66). For culverts, regulations 62 and 63 sets out the requirements for information that has to be collected and supplied to the regional council.

5.1.6 National Policy Statement for Indigenous Biodiversity (NPS-IB)

The National Policy Statement for Indigenous Biodiversity (NPS-IB) came into effect in August 2023. The NPS-IB applies to indigenous biodiversity in the terrestrial environment, which is defined as (emphasis added):

> *land and associated natural and physical resources above mean high-water springs,* ***excluding land covered by water, water bodies and freshwater ecosystems*** *(as those terms are used in the National Policy Statement for Freshwater).*

Accordingly, the NPS-IB is not relevant to this assessment.[2]

[2] While there are discrete exemptions to this (refer to Clause 1.3(2)(c) to (e), the exceptions do not relate to activities undertaken as part of the WNP.

6.0 Description of Methods

6.1.1 Wetland Delineation and Ecological Survey

As outlined above, the NPS-FM and NESF require specific assessments of wetlands to determine their status and extent. Methods followed the wetland delineation protocols referenced in the NPS-FM. An outline of these delineation methods is provided in Appendix 2.

Following the release of the National Policy Statement: Freshwater Management (2020) and associated National Environmental Standards, surveys were conducted on the features near the downstream extent of each of the Tributaries of the Mataura Stream (tributaries 1 and 2) at Willows Road Farm, the headwater gully at Gladstone Hill, and at TB1 within the Northern Rock Stack (following the wetland delineation protocols outlined in NPS-FM). The overland portion (outside of the existing road corridor) of a proposed buried services trench route connecting the Willows Road Farm to the existing Waihi Plant was also assessed for wetland features. Surveys were conducted during spring 2020, and in summer and autumn of 2021.

Follow-up surveys were undertaken in May and September 2023 to review results in light of January 2023 amendments to the natural inland wetland definition in the NPS-FM and following Cyclone Gabrielle (February 2023) which resulted in landslides and destruction of culverts in Willows Road Farm tributaries 1 and 2, modifying the features present.

6.1.2 Desktop Assessment and Survey of Freshwater Ecology

A review was undertaken of all available literature and aerial imagery to assist in identifying ecological values within respective watercourses and wetlands. This included water quality, periphyton, macroinvertebrates, and fish surveys from the Ohinemuri River and Ruahorehore Stream as part of OGNZLs permit to discharge treated water to the Ohinemuri River (data used from 2016 to 2021 reports; Golder Associates and Ryder Environmental Ltd), as well as more recent and water quality and ecological data collected from the Mataura Stream.

Records from the New Zealand Freshwater Fish Database were also accessed to provide data on the fish species present within different catchments. The recording of fish species threat classifications was as per DOC (2018a) and macroinvertebrates as per DOC (2018b).

WRC criteria for determining significance of indigenous biodiversity were used to assess the significance of the respective watercourses (Mataura Stream, Ruahorehore Stream and TB1 watercourse).

Methods used for the ecological survey of streams is shown in Appendix 3.

6.1.3 Assessment of Water Quality

The gathering and reporting of water quality of the Ohinemuri River and associated tributaries (especially the Ruahorehore Stream) has been carried out since the mid-1980s and continues to the present day. Regular monitoring of water quality (and ecology) has been carried out every year since 1987 by OGNZL (and its antecedent organisations) for the purpose of assessing compliance with limits set out in existing resource consent conditions. We note that these existing water quality limits are established as site-specific water quality criteria for the protection of aquatic life within the Ohinemuri River.

Accordingly, our approach has been to utilise and summarise the existing information, and except for samples collected from the Mataura Stream, no new water quality data has been collected from the Ohinemuri River for the purpose of this application. Instead, we have used the existing water quality data to describe the condition of the Ohinemuri River. In our view the existing water quality and ecological monitoring data are adequate to describe the condition of the Ohinemuri River.

Water quality data collected by OGNZL from the Mataura Stream between 2015 and 2018 was assessed and additional samples for water quality analysis were collected from two sites (Mataura Stream and Tributary 2) within the Mataura Stream catchment. The results are compared with the site-specific criteria established for the Ohinemuri River as described above and WRC water quality guidelines[3] for water quality.

Where appropriate, water quality is also assessed against the relevant NOF attribute values.

6.1.4 Assessment of Ecological Values and Effects of WNP

Ecological value has aspects of both quantity (rarity or extent) and quality (integrity, functionality or condition) and incorporates an array of attributes across multiple levels of ecological organisation (species, communities, habitats and ecosystems).

Environment Institute of Australia and New Zealand (EIANZ) impact assessment guidelines (EIANZ 2018) provide a summary scale whereby a site's value is assessed as the extent to which an area or site exemplifies qualities of representativeness, rarity/ distinctiveness, diversity and pattern, and ecological context characteristic of its ecosystem type and then ranked on a scale of Negligible to Very High for how many of those assessment matters are met (Table 1). We have assessed terrestrial and wetland ecosystems / communities / habitats and species against these criteria to determine the overall value of the features.

Table 1: *EIANZ criteria for ascribing ecological value (EIANZ 2018).*

Value	Description
Very high	Area rates High for 3 or all of the four assessment matters (representativeness, rarity/ distinctiveness, diversity/pattern, ecological context)
High	Area rates High for 2 of the assessment matters, Moderate and Low for the remainder, or Area rates High for 1 of the assessment matters, Moderate for the remainder
Moderate	Area rates High for one matter, Moderate and Low for the remainder, or Area rates Moderate for 2 or more assessment matters Low or Very Low for the 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.
Negligible	Area rates Very Low for 3 matters and Moderate, Low or Very Low for remainder.

Freshwater values were assigned based on the attributes outlined in the EIANZ guidelines. Ecological values are ranked on a scale of Negligible, Low, Moderate, High, or Very High based on these characteristics (Table 2).

[3] Guideline values sourced from https://www.waikatoregion.govt.nz/Environment/Natural-resources/Water/Rivers/healthyrivers/How-we-measure-quality/#:~:text=Water%20quality%20is%20measured%20by,may%20be%20unacceptable%20for%20others. on 24/07/2020.

Table 2: *Criteria for classification of freshwater stream ecological values (BML interpretation).*

Value	Explanation	Characteristics
Very High	A reference quality watercourse in condition close to its pre-human condition with the expected assemblages of flora and fauna and no contributions of contaminants from human induced activities including agriculture. Negligible degradation e.g., stream within a native forest catchment.	• Benthic invertebrate community typically has high diversity, species richness and abundance. • Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and settled sediments. • Benthic community typically with no single dominant species or group of species. • MCI scores typically 120 or greater. • EPT richness and proportion of overall benthic invertebrate community typically high. • SEV scores high, typically >0.8. • Fish communities typically diverse and abundant. • Riparian vegetation typically with a well-established closed canopy. • Stream channel and morphology natural. • Stream banks natural typically with limited erosion. • Habitat natural and unmodified.
High	A watercourse with high ecological or conservation value but which has been modified through loss of riparian vegetation, fish barriers, and stock access or similar, to the extent it is no longer reference quality. Slight to moderate degradation e.g., exotic forest or mixed forest/agriculture catchment.	• Benthic invertebrate community typically has high diversity, species richness and abundance. • Benthic invertebrate community contains many taxa that are sensitive to organic enrichment and settled sediments. • Benthic community typically with no single dominant species or group of species. • MCI scores typically 80-100 or greater. • EPT richness and proportion of overall benthic invertebrate community typically moderate to high. • SEV scores moderate to high, typically 0.6-0.8. • Fish communities typically diverse and abundant. • Riparian vegetation typically with a well-established closed canopy. • No pest or invasive fish (excluding trout and salmon) species present. • Stream channel and morphology natural. • Stream banks natural typically with limited erosion. • Habitat largely unmodified.
Medium	A watercourse which contains fragments of its former values but has a high proportion of tolerant fauna, obvious water quality issues and/or sedimentation issues. Moderate to high degradation e.g., high-intensity agriculture catchment.	• Benthic invertebrate community typically has low diversity, species richness and abundance. • Benthic invertebrate community dominated by taxa that are not sensitive to organic enrichment and settled sediments. • Benthic community typically with dominant species or group of species.

		• MCI scores typically 40-80. • EPT richness and proportion of overall benthic invertebrate community typically low. • SEV scores moderate, typically 0.4-0.6. • Fish communities typically moderate diversity of only 3-4 species. • Pest or invasive fish species (excluding trout and salmon) may be present. • Stream channel and morphology typically modified (e.g., channelised) • Stream banks may be modified or managed and may be highly engineered and/or evidence of significant erosion. • Riparian vegetation may have a well-established closed canopy. • Habitat modified.
Low	A highly modified watercourse with poor diversity and abundance of aquatic fauna and significant water quality issues. Very high degradation e.g., modified urban stream.	• Benthic invertebrate community typically has low diversity, species richness and abundance. • Benthic invertebrate community dominated by taxa that are not sensitive to organic enrichment and settled sediments. • Benthic community typically with dominant species or group of species. • MCI scores typically 60 or lower. • EPT richness and proportion of overall benthic invertebrate community typically low or zero. • SEV scores low, typically less than 0.4. • Fish communities typically low diversity of only 1-2 species. • Pest or invasive fish (excluding trout and salmon) species present. • Stream channel and morphology typically modified (e.g., channelised). • Stream banks often highly modified or managed and maybe highly engineered and/or evidence of significant erosion. • Riparian vegetation typically without a well-established closed canopy. • Habitat highly modified.

6.1.5 Waikato Regional Council RPS

The Waikato Regional Council (WRC) RPS sets out the criteria for identifying areas of significant indigenous biodiversity and their characteristics as they exist at the time the criteria are being applied[4] (WRC 2016). Criteria[5] may be specific to a habitat type including water, land or airspace or be more inclusive to address connectivity, or movement of species across habitat types.

The significance of ecological habitat within the proposed project footprint was evaluated using the ‘Criteria for determining significance of indigenous biodiversity’ in Section 11A of the RPS.

[4] Section 11A Indigenous Biodiversity.

[5] Table 11-1 Criteria for determining significance of indigenous biodiversity.

This criteria states that *"To be identified as significant an area needs to meet one or more of the criteria identified in the table below" (*i.e. in Table 11-1 of the RPS (Appendix 1 our report)).

In the context of wetlands, it is worth drawing attention to criterion 4 which states:

> "*It is indigenous vegetation, habitat or ecosystem type that is under-represented (20% or less of its known or likely original extent remaining) in an Ecological District, or Ecological Region, or nationally."*

The proportion of wetland habitat remaining in the Waikato Region and nationally is estimated to be 8.9% and 10.1% respectively (Ausseil et al., 2008). Consequently, wetlands are considered a conservation priority and indigenous wetland habitat qualifies as significant indigenous biodiversity under criterion 4 in the RPS.

Notwithstanding the above, we note that none of the wetlands identified in the project footprint have been recognised as Significant Natural Areas in the HDP.

The Ohinemuri River catchment is not identified as a priority catchment or as an outstanding freshwater body (although the Waihou River at Whites Road is listed to be included as outstanding) in the WRPS (section 8.2.1).

6.1.6 Evaluating the Level of Effect

The ecological effects of the project have primarily been assessed using the indicative footprint of works. Under the EIANZ criteria we have used, the level, or severity of adverse effects on an ecological feature or process is determined by the magnitude of the effect, the nature of the effects, and the ecological value of the site of component (EIANZ 2018).

The EIANZ assessment method uses matrices to provide a basis for clear and comparative assessments of the magnitude of effects (Table 3) and the associated impact on ecological values (Table 4). These must be used in conjunction with a detailed explanation of how scores and evaluations have been derived. Assessment of the level of adverse effect excludes consideration of specific mitigation measures (i.e. it is a 'raw', unmitigated assessment), but does consider whether the effect could be potentially mitigated or remedied.

'Effect magnitude' scores were derived for each of the assessed ecological features based on the works proposed within the relative footprint, and ongoing effects associated with its functioning. Level of effect was assessed for each ecological feature and local fauna population using a matrix of 'effect magnitude' and 'ecological value' rankings. This matrix uses the ecological value assigned to each feature in combination with the magnitude of the effect of project activities on each feature to determine the overall level (i.e. seriousness) of the effect.

Table 4 shows how the loss, change or deviation from the existing or baseline ecological quantity and quality conditions can be described in terms of the extent and duration of alteration to describe the magnitude of effect. A scale of very high to negligible is widely accepted. Note that 'existing' and 'baseline' conditions may be the same, but they may differ when the existing environment is expected to change before the activity causing an effect takes place.

Table 3: *EIANZ criteria for describing magnitude of effect (EIANZ 2018). Magnitude of effect in this table is considered without mitigation.*

Magnitude	Description
Very high	• Total loss of, or very major alteration to, key elements/features/ of the existing baseline conditions, such that the post-development character, composition and/or attributes will fundamentally change 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 the post-development character, composition and/or attributes will be partially changed; and/or • Loss of a moderate proportion of the known population or range of the element/feature
Low	• Minor shift away from existing baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances or patterns; and/or • Having a minor effect on the known population or range of the element/feature
Negligible	• Very slight change from the existing baseline condition. Change barely distinguishable, approximating to the 'no change' situation; and/or • Having negligible effect on the known population or range of the element/feature
Notes: We note that where the level of effect is noted as moderate, high or very high, mitigation is usually required. Therefore, the effects would typically be considered significant under the RMA.	

Table 4: *EIANZ criteria for level of ecological effect (EIANZ 2018).*

		Ecological Value			
		Very High	**High**	**Moderate**	**Low**
Magnitude	**Very High**	Very High	Very High	High	Moderate
	High	Very High	Very High	Moderate	Low
	Moderate	Very High	High	Moderate	Very Low
	Low	Moderate	Low	Low	Very Low
	Negligible	Low	Very Low	Very Low	Very Low

6.1.7 Effects Management

We have applied the ‘effects management hierarchy’ to the impacts of the proposed WNP (EIANZ, 2018). The effects management hierarchy outlines the order of priority for ecological impact management as:

a. Avoid.
b. Remedy.
c. Mitigate[6].
d. Offset.
e. Compensate.
f. And any supporting actions.

This effects management hierarchy is slightly different to the NPS-FM (refer to section 5.3), which seeks to avoid, ***minimise*** and then remedy effects (followed by offsetting or compensation). While the NPS-FM does not have specific reference to “mitigate”, it is generally encapsulated by the range of responses enabled when minimising or remedying effects.

Our approach to providing an environmental outcome for all of the project components has been one of integrating and aggregating the mitigation and offsets to maximise positive environmental outcomes. To this end we have adhered to the principles for aquatic offsetting and, as needed, aquatic compensation as per Appendices 6 and 7 of the NPS-FM respectively.

6.1.8 Integrated Effects Management

Our recommended integrated environmental effects management strategy provides for mitigation to be aggregated in specific locations within the OGNZL land ownership or where agreements exist with neighbouring landowners. Our strategy thus prevents a ‘patchy’ mitigation approach (whereby mitigation effort is dotted at irregular locations) and prefers a concentrated mitigation effort at selected locations. In addition, our integrated mitigation strategy has sought to enhance the ecological connectivity benefits.

Our integrated environmental mitigation strategy means that in most cases the ecological mitigation and the landscape mitigation planting take a similar form and are located in the same or proximal key locations. Ecology is integrated with landscape to provide a more continuous connection of vegetation and freshwater environments, which will benefit biodiversity whilst also providing benefit from a landscape and visual perspective. We have sought a net gain in biodiversity and ecological value in applying the effects management hierarchy along with this additional planting.

To this end, we note that this approach meets the requirements of Appendices 6 and 7 of the NPS-FM.

[6] We note that the effects management hierarchy detailed in the NPS-FM and in the NPS-IB does not include a step for mitigation.

7.0 Wharekirauponga Underground Mine

7.1.1 Introduction

The Wharekirauponga orebody is located approximately 11 km north of the township of Waihi. The resource lies beneath the CFP within the Wharekirauponga Minerals Mining Permit (60541) area. OGNZL is proposing to construct an access tunnel system to undertake further exploration and subsequent mining of the Wharekirauponga resource. The project will comprise surface infrastructure on farmland at Willows Road, a rock stack for overburden, tunnel portals, a tunnelling system, ventilation raises and the mine itself (Figure 4).

7.1.2 Wharekirauponga Project Activities

7.1.3 Background

The WUG Project Site has two components: the landholding owned by OGNZL and currently in use as a farm where the portal entrance and associated surface infrastructure will be constructed (Willows Road Farm); and a number of discrete sites (up to 9,290 m^2) within the Wharekirauponga Stream catchment in the CFP where the ventilation raises and egress shaft will be located.

The Willows Road Farm comprises 197 ha of primarily pastural land located approximately 5 kilometres north of the Waihi township. The site is accessed off SH25 at the foothills of the Coromandel Ranges. The wetland and freshwater assessment pertain to the Willows Farm Road location and WUG.

7.1.4 Water management

Proposed water management includes erosion and sediment control ponds located within the development to reduce sediment laden water from entering into the Mataura Stream (Southern Skies 2025). Initially, contact water from the tunnel and rock stack will be collected in the collection pond before being pumped via a dedicated pipeline located in the services trench to the existing WTP for processing and subsequent reuse/discharge in accordance with the consent conditions that apply to that discharge. Several other small ponds will be constructed across the site to intercept run-off water to allow solids to settle prior to return to Mataura Stream. These ponds will be designed to accommodate silt removal as required, with silt periodically removed and transported back the TSF decant ponds for disposal.

7.1.5 Rock stack

The design of the rock stack incorporates dish drains around the stockpile that separate catchment water from rock stack contact water. Catchment water will be diverted underneath the rock stack and discharged into the lower natural reaches of the tributary to maintain flows. On exhausting of the rock from the rock stack, tributary 2 will be rehabilitated and returned largely to its original configuration, with improved riparian areas and stock exclusion fencing to protect the waterway.

7.1.6 Topsoil stockpile

Topsoil derived from the project will be stored alongside but upslope of a small gully within Willows Farm. The storage area is well away from any permanent or intermittent streams. The topsoil will remain covered until such a time as it is required for rehabilitation. The location of the topsoil upslope and away from existing watercourses is not expected to result in any impacts to streams or wetlands.

7.1.7 Road crossings

Road crossing of tributaries on the farm will all be rebuilt as many include perched culverts preventing fish migration and are poorly constructed resulting in flood plain areas. Crossings and culverts will be designed to allow for fish and eel movement up the stream tributary corridors.

7.1.8 Services trench

A buried Services Trench connecting the Willows Road Farm to the existing Processing Plant will carry power, fibre optic cables and treated and potable water. Further details of the services trench are provided later in our report, and an assessment of effects of the services trench on freshwater values is the subject of a separate stand-alone report.

7.1.9 Wastewater

Human wastewater from the operations at Willows Road Farm will be treated on site by a package sewage treatment plant (STP). Discharge water from the STP will be directed into a transpiration pit (soak away) on the site. The transpiration pit will be located remotely from the Mataura Stream and its tributaries.

7.1.10 Wharekirauponga Stream

7.1.11 Background

The proposed WUG is a largely underground operation, and is expected to have only minimal expression on surface features occurring within the Coromandel Forest Park, mostly in the form of fenced vent raises. The WUG operations, while having minimal surface expression, may result in some dewatering of the hydraulically connected underlying rock mass. This potential dewatering is expected to cause flows in a small warm spring to cease, and there is a prospect that dewatering could cause reduced flows in some of the natural state water bodies. Further details of the effects of the potential reduced flows in water courses of the Wharekirauponga Stream catchment are provided in a stand-alone report ‘Wharekirauponga Stream Natural State: Effects of potential flow changes on natural state and aquatic ecology’ (Boffa Miskell 2024), and are summarised in section 14 below.

As the Wharaekirauponga Stream is centreplace as the surface catchment for the WUG operations, here we provided some detail of the ecological values of this watercourse and its tributaries.

7.1.12 Approach

Aquatic assessments were undertaken within the main stem, smaller lower tributaries and upper tributaries of the Wharekirauponga Stream aquatic habitat (i.e. Thompson Stream, Adams Stream, Edmonds Stream, Teawaotemutu Stream (Figure 4, Appendix 4). In addition, the value and potential effect of the loss of a small warm water spring was assessed and is discussed separately below.

Stream surveys were undertaken across consective days in 2019 (29 January – 1 February) and 2024 (12-16 February). Weather conditions prior to, and during, the survey were hot and dry with no significant rainfall events in the preceding three weeks. Ecological surveys undertaken included water physicochemistry, periphyton, macrophytes, marcoinvertebrates and fish communities. No macrophytes were present at any of the survey sites.

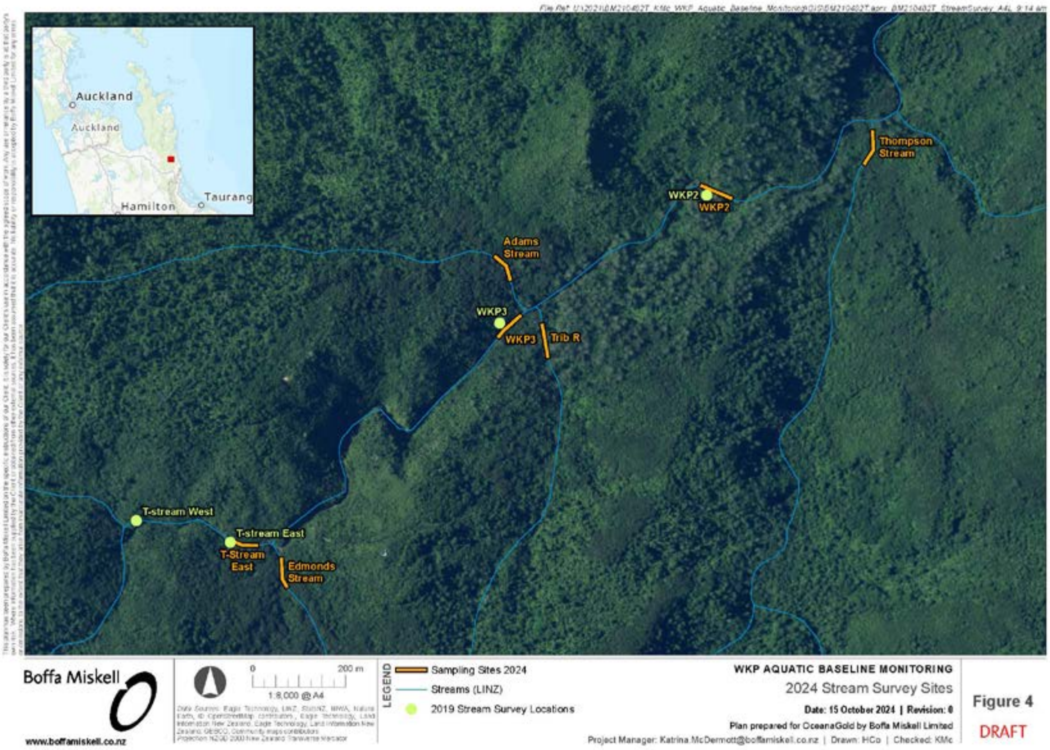

Figure 4: *Sample locations within the Wharekirauponga Stream.*

7.1.13 Water Physiochemistry

Spot water quality measurements were taken at each site at the time of the surveys using a handheld YSI meter. Spot measurements were undertaken during summer, within a particularly hot, dry period of weather. General water quality across the sites was excellent, with measured parameters representative of good ecosystem functionality (Table 5).

Water temperatures had a range of 17.9°C - 18.5°C in 2019 and 14.3 - 15.7 °C in 2024. In 2019 there was a heatwave passing over New Zealand and the resulting water temperatures were considered to be fairly high and may be stressful for some invertebrates such as stoneflies (Biggs et. al., 2002). Temperatures in 2024 were generally considered suitable for most invertebrates and periphyton.

Dissolved oxygen levels at all sites were very good, with all sites above 80% saturation in 2019 and 2024.

pH at all sites was near neutral in both 2019 and 2024, ranging from 7.18 – 7.95. These values are good for stream life (Biggs et al., 2002).

Conductivity levels in 2019 ranged from 117.5 to 126.4 µS/cm and in 2024 ranged between 64.9 to 76.7 µS/cm and in all cases were indicative of a low level of nutrient enrichment (Biggs et al., 2002).

Table 5: *Measured water physiochemistry results at freshwater survey sites, January and February 2019, and February 2024.*

	T-Stream West	T-Stream East		Edmonds Stream	WKP-3		Adams Stream	Trib-R	WKP-2		Thompson Stream
	2019	**2019**	**2024**	**2024**	**2019**	**2024**	**2024**	**2024**	**2019**	**2024**	**2024**
Temp (°C)	18.5	18.5	14.6	14.3	18.4	15.7	14.3	15.3	17.9	15.4	14.6
DO (mg/L)	9.8	10.04	10.14	9.98	9.92	10.0	10.15	9.77	10.30	10.2	9.83
DO % Sat	104.7	107.1	99.6	97.3	105.6	100.6	99.0	97.5	108.9	102.1	96.7
pH	7.95	7.57	7.18	7.56	7.61	7.44	7.23	7.55	7.79	7.46	7.45
Conductivity (µS/cm)	118.5	117.5	66.4	64.9	126.0	70.1	69.7	76.7	126.4	70.4	75.6

7.1.14 Periphyton

Total Periphyton mean cover ranged from 55% at site T-Stream West, to 87% at site WKP-2 in 2019. Cover in 2024 was similar with 59 % at Site Trib-R to 89.6 % at Thompson Stream.

Periphyton cover group ‘thin/mat film’, or diatoms, was the dominant group at sites T-Stream West, T-Stream East and WKP-2 in 2019. In 2024 it was the dominant type at sites Edmonds Stream, WKP-3, Adams Stream and Trib-R. ‘Medium mat’ was the dominant group at site WKP-

3 in 2019. In 2024 short filamentous algae was the dominate type at T-Stream East and Thompson Stream, while long green filamentous algae dominated at site WKP-2.

In 2019 filamentous algae was rare across sites, while in 2024 it was common. In 2019 long filamentous algae was only present at site WKP-2 where it had an average coverage of 23%. In 2024 it was dominant type at site WKP-2 with measured cover (31.6%) above the New Zealand Periphyton Guideline (Biggs, 2000) for periphyton cover within gravel/cobble bed streams for protection of instream values of aesthetics/recreation and trout habitat.

Mean periphyton cover for diatoms / cyanobacteria (>3 cm thick) was well below the aesthetic/recreation (1 November – 30 April) guideline value of a maximum streambed cover of 60%, across all sites in both 2019 and 2024.

Periphyton communities were representative of healthy communities and good water quality. Communities in both 2019 and 2024 were dominated by diatoms from the phyla Bacillariophyceae, with 16 and 24 species identified, respectively. Blue-green algae, or cyanobacteria, were recorded in lower abundance across all sites with seven species identified in 2019 and 15 in 2024. Species of desmids (Zygnemophyceae), golden-brown algae (Cryptophyceae), red algae (Rhodophyta) and flagellates were also recorded at some sites.

Mean chlorophyll-a concentrations were below the threshold of 50 mg/m^2 for the protection of benthic biodiversity (Biggs, 2000) at all sites in 2019 and only two sites in 2024 (T-Stream East and Edmonds Stream). Mean Ash Free Dry Weight (AFDW) was below the threshold of <35 g/m^2 for the protection of aesthetics / recreation and trout habitat and angling (Biggs, 2000) at all sites in 2019. In 2024 sites Adams Stream and Thompson Stream were above the AFDW threshold.

7.1.15 Macroinvertebrate Assemblages

Macroinvertebrate communities were diverse across all sites and representative of high-quality stream habitats, with high abundance of EPT taxa present across all sites (Table 6). All communities, except Thompson Stream, were dominated by sensitive EPT taxa (Ephemeroptera, Trichoptera and Plecoptera), comprising at least 67% and 60% of all individuals present in 2019 and 2024, respectively. Thompson Stream was dominated by the taxa group Gastropoda.

Individuals from taxa groups Gastropoda (snails), Diptera (true flies), Coleoptera (beetles) and Megaloptera (toe biters) were also recorded with a range of other groups present in much lower abundance including chironomid midges.

Table 6: *Macroinvertebrate metrics. Means (n=6) are presented, January and February 2019, and February 2024 in the Wharekirauponga Catchment.*

	T-Stream West	T-Stream East		Edmonds Stream	WKP-3		Adams Stream	Trib-R	WKP-2		Thompson Stream
	2019	**2019**	**2024**	**2024**	**2019**	**2024**	**2024**	**2024**	**2019**	**2024**	**2024**
Total abundance	220	276	666.6	329.5	176	748.3	142.6	237	810	1139.1	478.8
No. of taxa	18.0	20.7	25.8	23.6	16.2	26.1	22	25.3	26.0	30.1	22.6
No. of EPT taxa	12.3	13.5	16.8	15.1	11.0	16	13	14.5	16.7	18.5	9.6
Percent EPT taxa	69.3	64.1	65.5	64.5	69.3	60.9	59.5	56.2	64.1	61.3	42.4
MCI score	135.8	135.3	133	137	129.8	123	135	130	113.8	115	108
QMCI score	7.8	8.0	7.68	6.55	7.3	7.67	6.81	7.22	6.2	6.402	4.09

7.1.16 Fish Communities

Fish communities were diverse for the sampling sites with a total of six different species present across sampling sites in both 2019 and 2024. The Wharekirauponga Waterfall is located downstream of sites T-Stream East and Edmonds Stream. The waterfall is approximately 4 m in height and presents a significant fish barrier, with distinct differences in fish communities observed between sites located upstream and downstream. No introduced fish species were observed at any of the survey sites.

Sites T-Stream and Edmonds Stream are both upstream of the Wharekirauponga Waterfall. In 2019 longfin eel and kōaro were present at both T-Stream West and T-Stream East, while shortjaw kokopu was found at site T-Stream East. In 2024 longfin eel and kōaro were present at T-Stream East and Edmonds Stream. Juvenile eels, or elvers, were also present at all sites in 2019 and 2024.

Sites WKP-3 and WKP-2 are both located downstream of the Wharekirauponga Waterfall and both have a more diverse fish community than the sites upstream. This diversity is in no doubt owing to their comparatively easy accessibility from the sea. In addition to longfin eel (*Anguilla dieffenbachii)* and kōaro (*Galaxias brevipinnis*), torrentfish (*Cheimarrichthys fosteri*), redfin bully (*Gobiomorphus huttoni*) and common smelt (*Retropinna retropinna*) were also present at both WKP- sites in 2019. In 2024 fish communities were very similar except no common smelt were observed, and banded kōkopu were observed at both sites. Elvers were also present at both sites across both sampling years.

Sites Adams Stream, Trib-R and Thompson Stream are all smaller tributaries of the Wharekirauponga Stream, located downstream of the Waterfall and were only surveyed in 2024. Adams Stream had redfin bully, longfin eel, banded kōkopu and a single common bully. Trib-R and Thompson stream had redfin bully, longfin eel, banded kōkopu and elver, while Thompson stream had the same species except elver.

7.1.17 Warm spring

7.1.18 Overview

A warm spring emerges from the ground some 5 m from the true right bank of the main stem of the Wharekirauponga Stream between the Trib R and the Edmonds Stream tributaries, 120 m upstream of the hydrological monitoring site named WKP-3. It has been measured with a mean flow of ca. 6.67 L/s[7]. The spring emergence occurs in a pool area heavy in orange deposit (see Figure 5 below), before passing as a shallow sheet flow cascading over rocks (also heavy in bed orange deposit) some 5 m to discharge into the main stem of the Wharekirauponga Stream. There is minimal aquatic habitat present, and it is poor habitat for macroinvertebrates and fish as it is shallow and smothered in a heavy deposit (Figure 5). No fish were observed and are unlikely to be present in this shallow short reach, which connects via a short cascade to the main river.

7.1.19 Warm spring temperature and water quality

Geothermal environments are characterised by temperature gradients, exposure to steam, have highly mineralised soils and waters, and often extreme pH. In addition, typically clear distinctions in aquatic flora and fauna occur longitudinally downstream from thermal springs[8]. Immediately below the source of high-temperature thermal fluids the aquatic communities are usually dominated by thermophilic fungi, cyanobacteria and archaebacteria before a more diverse array of algae may appear. Typically, this occurs as the thermal water cools and geothermally adapted invertebrates begin to occur (around 47-55^{o}C).

The temperature of the emerging spring waters at Wharekirauponga Stream is 19-21^{o}C, which represents a very weak temperature signature relative to most geothermal springs in New Zealand.

Geothermal waters in New Zealand tend to separate into two main types: alkali-chloride and/or bicarbonate type or acid-sulfate and/or chloride type (Hunt and Bibby 1992, Boothroyd 2009). GWS (2021) sampled the warm spring waters and show that it has moderately raised SO_4, sodium, moderately raised metals and is a calcium bicarbonate dominant water type. These characteristics reflect a weak signature compared to other more highly mineralised geothermal systems in New Zealand.

7.1.20 Algal communities

A further visit to the warm spring was undertaken on 19 September 2022 to sample the algal and benthic deposit material. Samples were obtained from within the pool and two locations within the spring outlet[9]. The algae were identified at the NIWA laboratory in Hamilton and the results are provided in Table 7.

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[7] Mean from December 2021 to August 2024

[8] We note that in the proposed Natural and Built Environment Bill (Sub-part 2, Cl. 7) geothermal water is defined as: (a) means water heated within the earth by natural phenomena to a temperature of 30 degrees Celsius or more; and (b) includes all steam, water, and water vapour, and every mixture of all or any of them that has been heated by natural phenomena.

[9] Each sample comprised eight scrapes from the surface of rocks and pooled together for identification and rank abundance assessment.

	
a) Warm spring point of emergence.	b) Warm spring fall into Wharekirauponga Stream.

Figure 5: *Warm water spring within Wharekirauponga Stream catchment. a) Point of emergence with presence of orange algae. b) The discharge over a small fall into the main stem of the Wharekirauponga Stream.*

Table 7: *Algal communities occurring within the warm spring and outlet at Wharekirauponga Stream, September 2022. 1=abundant, 10=rare.*

	Sample location		
Algal taxon	**Lower-outlet**	**Mid-outlet**	**Spring pool**
Cyanobacteria			
Pseudanabaena sp.	7	1	
Geitlerinema splendidum	3		
Bacillariophyceae			
Achnanthidium sp.	6		
Cocconeis sp.		3	
Diatoma sp.	9		
Nitzschia sp.	1	2	
Navicula sp.	2		
Pennate diatoms	5		
Pinnularia sp.	4		
Flagellates	8		
Precipitate			1

No algae were recorded from material collected within the spring pool. This material had no biological structure to the filaments which indicates that it is not algae or bacteria and is likely a precipitate or detrital material. We note that the filamentous eubacteria (Chloroflexaceae) can be responsible for the orange colouring of mats and films in geothermal waters, but we were unable to confirm if this was the case at this location.

Cyanobacteria (blue-green algae) were most abundant in the algal community immediately below the spring (mid-outlet), but with only two other diatom taxa recorded (*Nitzschia* and *Cocconeis*). Blue green algae are a common component but not exclusive to geothermal waters. Lower down the spring outlet the algal community was more diverse with diatoms most common, whilst Cyanobacteria remained present.

The Cyanobacteria and diatom taxa are cosmopolitan forms that commonly occur in a variety of aquatic ecosystems in New Zealand including temperate and geothermal ecosystems (Boothroyd 2009). Most notable was the presence (although not dominance) of the pennate[10] diatom *Pinnularia* which can be a distinguishing feature of geothermal ecosystems in New Zealand compared to other hot spring systems in other countries (Owen et al. 2008). For example, *Pinnularia* dominates at the Waiotapu[11] geothermal field (pH ~2.6; temperature: 29 ◦C), while a range of diatoms is known to occur at Waimangu[8] geothermal area (pH ~6.5; temperature: 52 ◦C), including *Nitzschia, Gomphonesis* and *Fragilaria*.

The absence of dominance of geothermal algae suggests a weak thermal signature of the ecosystem, and a more immediate transition to a cooler temperature dominant community of algae. As outlined above, GWS (2021) sampled the spring waters and show that it is a bicarbonate dominant water type. However, the algal communities do not reflect a unique geothermal flora and are more reflective of a temperate water community with some representation of algae also found in geothermal waters. Accordingly, the algal communities do not represent a unique or geothermally representative flora at the warm spring.

7.1.21 Macroinvertebrates

Two macroinvertebrate samples (samples a and b, Table 8) were taken to better understand the ecological value of the aquatic community of this feature, as we wanted to understand if the specific chemistry has produced an unusual aquatic macroinvertebrate community. The common snail *Potampoyrgus antipodarum* was the dominant organism within the watercourse. No unique or unusual macroinvertebrates were encountered.

Boothroyd (2009) noted that bicarbonate geothermal waters tended to have a distinctive macroinvertebrate community dominated by *Tanytarsus* sp. and *Ephydrella thermarum* which did not appear to be present at the warm spring site. Accordingly, the lack of the presence of these defining fauna does not suggest a unique or representative geothermal ecosystem at this location. In the absence of highly specific warm/chemical spring signature at this location we have applied the standard aquatic macroinvertebrate metrics (notably the MCI) to be consistent with our approach to the non-geothermal waters.

The freshwater metrics applied to the warm spring increased from higher in the outlet to the lower reaches, with the MCI recording a poor to fair condition. Taxa number close to the outlet with the Wharekirauponga Stream was higher than closer to the spring pool. For the most part

[10] Having bilateral symmetry

[11] Located in the Central Volcanic Plateau.

the macroinvertebrates reflected the biota recorded in the Wharekirauponga Stream with some exceptions that nevertheless probably also occur in the stream.

As outlined above, GWS (2021) sampled the spring waters and show that it has moderately raised SO_4, sodium, moderately raised metals and is a calcium bicarbonate dominant water type. It is sufficiently unusual in the environs as to reduce the diversity and abundance of the typical macroinvertebrate and floral community, by excluding species intolerant of the specific water quality characteristics, but not so unusual as to produce a unique flora and fauna community.

7.1.22 Interaction with Wharekirauponga Stream

The warm spring enters the Wharekirauponga Stream contributing warm fluids to the cool freshwater ecosystem. We noted the continuation of the orange deposit for some 5-10 m along the true right margins of the Wharekirauponga Stream (Figure 5), although at other times of the year, we also observed that this phenomenon was much reduced. There may be some local influence of the discharge within the Wharekirauponga Stream, notably from sulphate, but we would expect that to dissipate rapidly within the receiving environment.

7.1.23 Summary

The ecological characteristics of the warm spring and its outlet reflected very weak temperature and water quality signature for geothermal systems, and the characteristics of the biological communities were very weak compared to more typical geothermal ecosystems in New Zealand. However, the lack of the presence of any defining flora or fauna, and the greater emphasis of a more temperate and cosmopolitan biota does not suggest a unique or representative geothermal ecosystem at this location. Accordingly, we did not consider the warm spring to have particular or strongly distinguishing geothermal ecological values, and we have recorded the warm spring as a **Low** ecological value.

Table 8*: Aquatic macroinvertebrate metrics for two samples collected within the warm spring and the Wharekirauponga Stream tributary, April 2020.*

Metric	Warm spring sample a	Warm spring sample b	Wharekirauponga Stream tributary
Total abundance	59	23	681
Number of taxa	20	4	29
Number of EPT taxa	7	0	15
MCI score	95	65	129
QMCI	4	3.9	6.0

7.1.24 Summary of Ecological Values

The freshwater habitats surveyed within the Wharekirauponga Stream and its tributaries are of Very High ecological value. All habitats are classified as significant, providing habitat and migratory pathways to a number of Threatened and At-Risk native fish species (WRC 2016). The ecological values of the warm spring were assessed as Low.

Habitats support a diverse community of native flora and fauna including Threatened and At-Risk fish species and sensitive macroinvertebrate taxa. Measured water physiochemistry parameters at the time of sampling demonstrated good ecosystem functionality. Periphyton communities were abundant in taxa and indicative of good quality streams. Macroinvertebrate communities were diverse in sensitive EPT taxa, with QMCI scores all excellent. Fish communities comprised several Threatened and At Risk species with habitats also providing important migratory pathways.

7.1.25 Waiharakeke Stream

7.1.26 Background

The Waiharakeke Stream catchment begins immediately north of the Mataura Stream catchment with numerous tributaries that feed into two branches. Both branches flow in a north easterly direction before combining and eventually discharging into the Otahu River. Two assessment sites within the Waiharakeke Stream catchment were sampled on 26 August 2020.

7.1.27 Waiharakeke Tributaries

The two assessment sites were located on tributaries connecting to the main stems of the Waiharakeke Stream (main stem and right branch). Both reaches comprised similar habitat features. The watercourses flow at the base of mostly steeply graded gully systems and followed a natural flow-path with no modification observed across the assessed reaches. The hard-bottom stream beds consisted of a range of substrate including gravels, cobbles, boulders and bed rock. Silt and sand made up a small proportion and occurred behind logs or large rocks near the edge of the stream. Detail of the stream morphology and substrate is provided in Appendix 4.

7.1.28 Macroinvertebrate Assemblages

The Waiharakeke Stream had a diverse range of EPT taxa, although many of the species were recorded as low in abundance (Table 9). A diverse range of EPT taxa is indicative of reasonable water quality and instream habitat. We note that Waiharakeke Stream sites likely had a high flow, relative to baseline conditions, at the time of sampling which may have flushed individuals downstream and resulted in lower numbers of, not just EPT taxa but, all macroinvertebrates. This would explain the low macroinvertebrate abundance for the sample, despite abundant instream habitat.

Indices from the Waiharakeke Stream sites were all indicative of “excellent” water and/or habitat quality[12]. Results from all samples reflect the abundance of sensitive EPT taxa. The SQMCI score considers the relative abundance of each taxa in the sample and is calculated using the proportional abundance of each scoring taxa. It is thus a better index of a community’s composition, whereas the MCI is strongly influenced by rare taxa which contribute to the MCI score disproportionally to their abundance.

[12] Interpretation of the classification of MCI and QMCI scores is provided in Table 3-3 of Appendix 3 of this report.

Table 9: *Summary of macroinvertebrate metrics for the Waiharakeke Stream.*

Metric	Waiharakeke Stream tributary	Waiharakeke Stream right branch tributary
Taxonomic richness	26	34
No. of EPT taxa	13	17
Percent EPT	50	50
MCI-hb	130.0	122.4
SQMCI-hb	7.0	6.9

7.1.29 Fish Communities

There are six records from the freshwater fish database for the Waiharakeke Stream catchment within the forest park. Species recorded included longfin eel, kōaro, banded kokopu (*Galaxias fasciatus*), shortjaw kokopu (*Galaxias postvectis*) and redfin bully. There are three records further downstream within more lowland habitat outside of the forest park which included additional species such as inanga (*Galaxias maculatus*), smelt (*Retropinna retropinna*), common bully (*Gobiomorphus cotidianus*) and giant bully (*Gobiomorphus gobioides*). Within the wider Otahu River and connecting tributaries, including the Wharekirauponga Stream catchment, fish species detected that are additional to those already mentioned included lamprey (*Geotria australis*), shortfin eel (*Anguilla australis*) and torrentfish. We consider it likely that, of the additional species, shortfin eel and torrentfish are most likely to be present within the stream reach. Torrentfish have a conservation status of At Risk (declining) while shortjaw kokopu are classified as Threatened (nationally vulnerable).

Fish index of biotic integrity (IBI) scores for the different assessed sites is provided in Table 10 .

Table 10*: Fish IBI scores for the Waiharakeke Stream.*

Assessed site	IBI score	Rating
Waiharakeke Stream tributary	60	Excellent
Waiharakeke Stream right branch tributary	60	Excellent

7.1.30 Stream Ecological Valuation

The two assessed reaches within the Waiharakeke Stream catchment comprised high overall SEV scores of 0.97 and 0.956, typical of unmodified upland stream sites within forested catchments. The streams did have slightly reduced scores for water temperature control as canopy cover was not as dense as might be expected in mature forest, with some gaps present, particularly for the assessed tributary along the right branch. The assessed reach along the main stem also had a comparatively lower score for riparian vegetation intact due to a small section that was naturally more incised.

7.1.31 Waiharakeke Stream: Summary of Ecological Values

The Waiharakeke Stream catchment has good instream habitat quality and quantity consisting of an array of different habitats, including, riffles, runs, pools, undercut banks and coarse woody debris. Fine sediment cover was minimal and only found in sheltered areas behind large woody debris or boulders. Macroinvertebrate assemblages and indices were reflective of the excellent-quality habitat with many sensitive taxa. Fish species records within the catchment also showed high diversity with seven native fish species recorded. Riparian vegetation and stream shading were high with vegetation consisting of late succession and mature forest species. The streams were in a natural state with no modification.

Based on the EIANZ criteria we have assessed the Waiharakeke Stream reaches as comprising **Very High** ecological value.

7.1.32 Wetland Delineation and Ecological Values

7.1.33 Mataura Wetland

Mataura Wetland is situated within Willows Road Farm and is ~2,815 m^2 (0.28 ha) in extent, including a well-defined, permanent wetland with a persistently high-water table (indicated by soil profiles) and transitional “damp area” where there is an obvious visual ecotone of wet tolerant grasses and rushes (Appendix 2). The feature is situated in the lower reaches of Tributary 1, near its confluence with Mataura Stream. Mataura wetland is not listed as an SNA in the HDP.

GHD (2022b) has developed a conceptual hydrology model for the wetland that concludes that the inferred water source for the defined wetland is a combination of surface water via runoff and direct rainfall, interflow from infiltrating rainfall within the catchment and groundwater baseflow.

Remnant historic wetland vegetation includes two mature swamp maire (*Syzygium maire*), a once common wetland tree, now with a threatened status raised to Nationally Critical in 2017, following the arrival of myrtle rust in NZ. The swamp maire population is largely reduced to small, sparse stands of trees within partially drained farmland, such as Mataura Wetland.

7.1.34 Tributary 1 Gully

The middle reaches of Tributary 1 (upstream of the access road) encompasse a steep–sided gully with a watercourse at the bottom. Historical photographs show that clearance for farmland had begun in the area by 1942 and was completely cleared by 1999.

At the time of the 2021 assessment, a constructed farm pond was present within the tributary, created by an embankment built across the stream to form the accessway. A small, elevated culvert was installed to provide for the detention of water while allowing the pond to drain before it overtopped the road. The downstream outlet of the pipe is perched, preventing the passage of fish upstream.

The sizing and location of the outlet pipe showed it had been developed as a farm pond for the purpose of retaining water. The feature (and associated wet tolerant vegetation around its margins) was excluded as a natural inland wetland because it was a deliberately constructed feature.

The Cyclone Gabrielle storm event destroyed the culvert beneath the access road and moved a large amount of sandy silt, pumice and other debris down the stream from slips higher up the catchment. This damage caused the pond to drain out, and a follow-up site visit in September 2023 identified wetland characteristics (saturated substrate, wet tolerant plants) across the former bed of the pond and a short distance upstream. The culvert beneath the access road had been replaced and was flowing freely, and no longer detaining water.

The feature is no longer a ‘deliberately constructed waterbody’ and (according to the September 2023 survey) has wetland characteristics and meets the definition of a natural inland wetland. We note that the characteristics of this feature are likely to change further and anticipate that downcutting of the watercourse through the sediment will form a more defined channel, reducing wetness of the surrounding substrate, and allowing colonisation of terrestrial vegetation. Therefore, we consider that the dimensions of the wetland feature indicated in Figure 6 are likely to reduce over time.

Nevertheless, and for the avoidance of any doubt, the wetland feature at Tributary 1 meets the definition of a natural inland wetland under the NPS-FM and the pasture exclusions do not apply.

7.1.35 Tributary 2 Gully

The middle reaches of Tributary 2 emerge from a small, steep-sided gully below a scrub covered hillslope, and is intersected by the access road which has been built up across a steep section of slope. At the time of the 2021 assessment, the culvert below the road had blocked, and a shallow basin had formed above it, containing a 90 m^2 patch of Mercer grass-dominated wetland with kikuyu and perennial rye grasses at the margins (heavily grazed and trampled by cattle). Delineation plots scored a PI < 3 (indicative of a wet-tolerant vegetation community) and thus met the definition of a wetland. Mercer grass is not classified as a pasture grass; therefore at that time, the feature met the definition as a natural inland wetland.

The Cyclone Gabrielle storm event destroyed the culvert beneath the access road and moved a large amount of clay, sandy silt, and pumice cobbles down the stream from slips higher up the catchment. A follow-up site visit in September 2023 (following repair of the road and culvert) found a clear, free-flowing stream meandering through a bare substrate of cobble, gravel and sandy silt. No ponding or evidence of wetland re-formation was observed.

Accordingly, and for the avoidance of any doubt, there is no wetland feature at Tributary 2.

7.1.36 Freshwater Ecology Values

7.1.37 Data Collection

In this section we provide an overview of the data collected from the assessed stream reaches (Table 11). Further descriptions of the methods used are detailed in Appendix 3. Locations of survey sites are provided in Figure 6.

Table 11: *Overview of the freshwater ecological attributes assessed at sample sites at Willows Road Farm, July – August 2020, January 2021, January 2023.*

Fieldwork Method	Mataura Stream	Tributary 1	Tributary 2 (impact site)	Tributary 3 (mitigation site)
Habitat values	✓	✓	✓	✓
Sediment & water quality	✓		✓	✓
Sediment cover	✓			
SEV		✓	✓	✓
Macroinvertebrates	✓	✓	✓	✓
Fish survey			✓	✓

7.1.38 Mataura Stream catchment

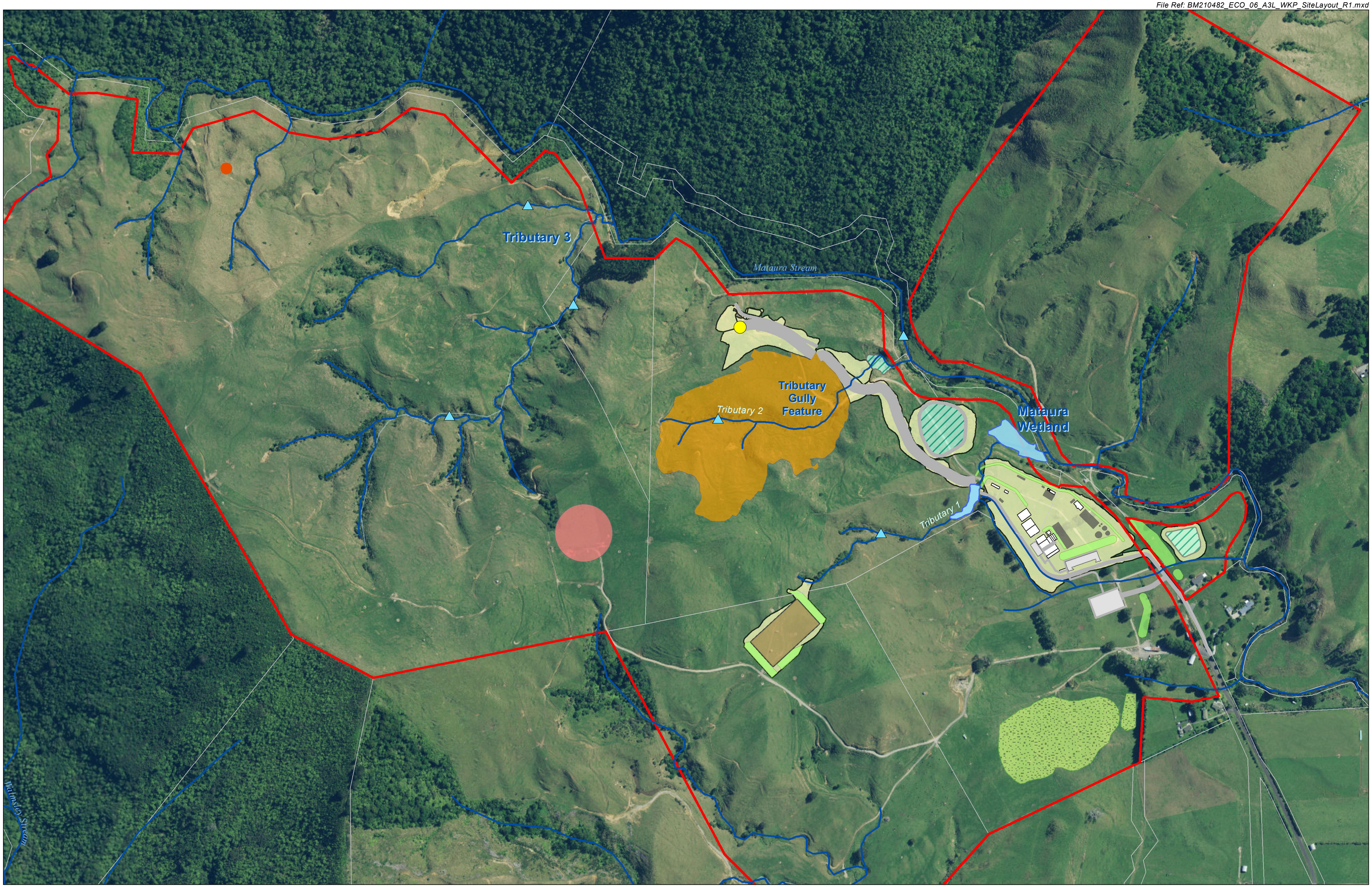
7.1.39 Background

The headwaters of the Mataura stream begin mostly within the native forested catchments of Coromandel Range, with several tributaries also feeding into the Mataura Stream from adjacent farmland. The perennial main stem flows in a south easterly direction (adjacent to the proposed works site) before discharging into the Ohinemuri River between Willows Road and Corbett Road. Tributary 2 which flows through the proposed works site is located within farmland south of the forested Coromandel Range, and west of the Mataura Stream. Tributary 3 is located north to the proposed works and within farmland gullies, with remanent riparian vegetation within the headwaters, and Tributary 1 is located to the south of the proposed works. All tributaries flow in an easterly direction and into the Mataura Stream.

The assessed reach of Mataura Stream (adjacent to the proposed works site) follows a natural flow-path at the base of a large gully system with gully sides that varied from steep to flat flood plains. The hard-bottom stream bed predominantly consists of gravels, cobbles and boulders with occasional areas of silt and sand in less exposed sites where flow velocities are reduced (i.e. stream edges). Fieldwork to assess the ecological values of the Mataura Stream and Tributary 1 was carried out in July 2020, and after further refinement of the project footprint, Tributary 2 was sampled in January 2021.

Tributary 3 has been identified as a potential mitigation site. The habitat assessments of Tributary 3 was completed in January 2023. Within Tributary 3, three sample locations were assessed (Northern Arm, Southern Arm Upper, Southern Arm Lower; see Figure 6 for sampling locations). For the purpose of this report a conservative approach was taken and the site with the highest SEV score (Southern Arm Lower) will be discussed in greater detail. A description of the habitat at all the sampled sites is provided in Appendix 4.

File Ref: BM210482_ECO_06_A3L_WKP_SiteLayout_R1.mxd



Boffa Miskell

www.boffamiskell.co.nz

0 200 m

1:6,000 @ A3

Data Sources:
Waterways and Roads sourced from LNZ data service
Proposed Infrastructure sourced from Oceana Gold

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Tunnel Portal
- Indicative Shaft
- Freshwater Sampling Site
- Wetland
- Willows Road Site
- Cadastre
- Access Road\Path
- Building Footprint
- Parking
- Bund
- Hard landscape
- Magazine Footprint
- Retention / Collection Ponds
- Willows Rock Stack
- Topsoil Stockpile
- Earthworks
- Helipad envelope (100m)

WAIHI NORTH PROJECT

Proposed Willows Road Site Layout

Date: 26 September 2024 | Revision: 1

Plan prepared for Oceana Gold by Boffa Miskell Limited

Project Manager: katherine.muchna@boffamiskell.co.nz | Drawn: HCo | Checked: KMc

Figure 6

7.1.40 Mataura Stream Water Quality

A summary of the water quality results collected at the three sampling sites (Mataura Stream, Tributary 2, Tributary 3) is provided in Table 12. We have compared the water quality of these three sites to WRC water quality guidelines and the NOF attributes where applicable.

Spot measurements from sampling sites showed healthy dissolved oxygen concentrations. Water temperature and pH are likely to fluctuate daily and with seasons. Heavy metal concentrations from the sediment quality analysis did not exceed applicable guidelines. Nutrient concentrations were generally low, with higher concentrations of nitrogen and phosphorus found in the Tributary 2 compared to Mataura Stream. This is to be expected with stock access excluded from the Mataura Stream as well as native forest (low nutrient source) comprising part of the upper catchment.

Water quality results for Mataura Stream were mostly within the WRC guidelines (Appendix 6) except for some nutrient parameters (total ammoniacal nitrogen, total phosphorus).

Table 12: *Water and sediment quality results from the Mataura Stream.*

Analytes	Units	Mataura Stream (2020)[a]	Mataura Stream 2015-2018 (n=3)[b]	Tributary 2[a]	Tributary 3[c]	WRC guideline	NOF
Temperature	ºC	12.6	15.4 - 18.9	14.7	17.7	<12 & <20	
Dissolved oxygen	mg/l	11.44	-	10.01	9.42	-	Band A[d]
	%	108.0	-	107.5	99.0	>80	
Conductivity	µs/cm	55.4	-	49.6	59.3	-	
pH	pH units	6.72	6.5 - 7.5	6.05	7.0	6.5 - 9	
Copper	g/m^3	-	0.0005	-	-	-	
Lead	g/m^3	-	0.0001	-	-	-	
Zinc	g/m^3	-	0.001 - 0.0023	-	-	-	
Nitrate	g/m^3	-	0.1 - 0.5	-	<0.002	-	Band A
Nitrite + Nitrate	g/m^3	-	0.1 - 0.5	-	0.58	-	
Total ammoniacal N	g/m^3	-	0.01 - 0.058	-	0.013	0.88	Band A-B
Total Phosphorus	g/m^3	-	0.005 - 0.049	-	0.011	0.04	
Dissolved reactive phosphorus	g/m^3	-	0.004 - 0.022	-	0.006	-	
Total suspended solids	g/m^3	-	3 - 7	-	-	-	
Sediment quality							
Total copper	mg/kg	10.0	-	13.0	-	-	
Total lead	mg/kg	6.0	-	12.3	-	-	
Total zinc	mg/kg	43	-	46.0	-	-	
Total phosphorus	mg/kg	210	-	730.0	-	-	
Total nitrogen	g/100g	<0.05	-	0.32	-	-	

[a] Data collected by Boffa Miskell, July 2020. [b] Data collected by OGNZL, 2015-2018. [c] Data collected by Boffa Miskell, January 2023.
[d] NOF states dissolved oxygen for use below point source discharges only.

7.1.41 Sediment Cover and Grain Size

As the land use of the main and tributary catchments of the Mataura Stream were more agricultural, we undertook a more critical analysis of the sediment conditions within the watercourses. The stream bed of all assessed sites was hard bottom, although Tributary 2 did comprise areas of mostly silt and sand material in lower gradient reaches. The Mataura Stream contained a diverse mix of different sized particles from silt and sand (<2 mm) to boulders (>256 mm). Sediment within the Mataura Stream was generally less than 10%, although there were less exposed areas which had greater sediment cover of between 20 to 50%. Tributary 3 had a range of substrate types from silt to bedrock, with large cobble the most dominant substrate (30%).

Fine sediment cover was within recommended guidelines (Clapcott et al. 2011) for biodiversity and salmonid spawning habitat within the Mataura Stream and tributary 3 but was above these limits (>20% fine sediment) in the Tributary 2. Similarly, the measure of deposited fine sediment fell within Attribute A of the NOF (Table 16, NPS-FM), while tributary 2 fell below the national bottom line.

Detail of the stream morphology and substrate is provided in Appendix 4 and sediment particle size in Figure 7.

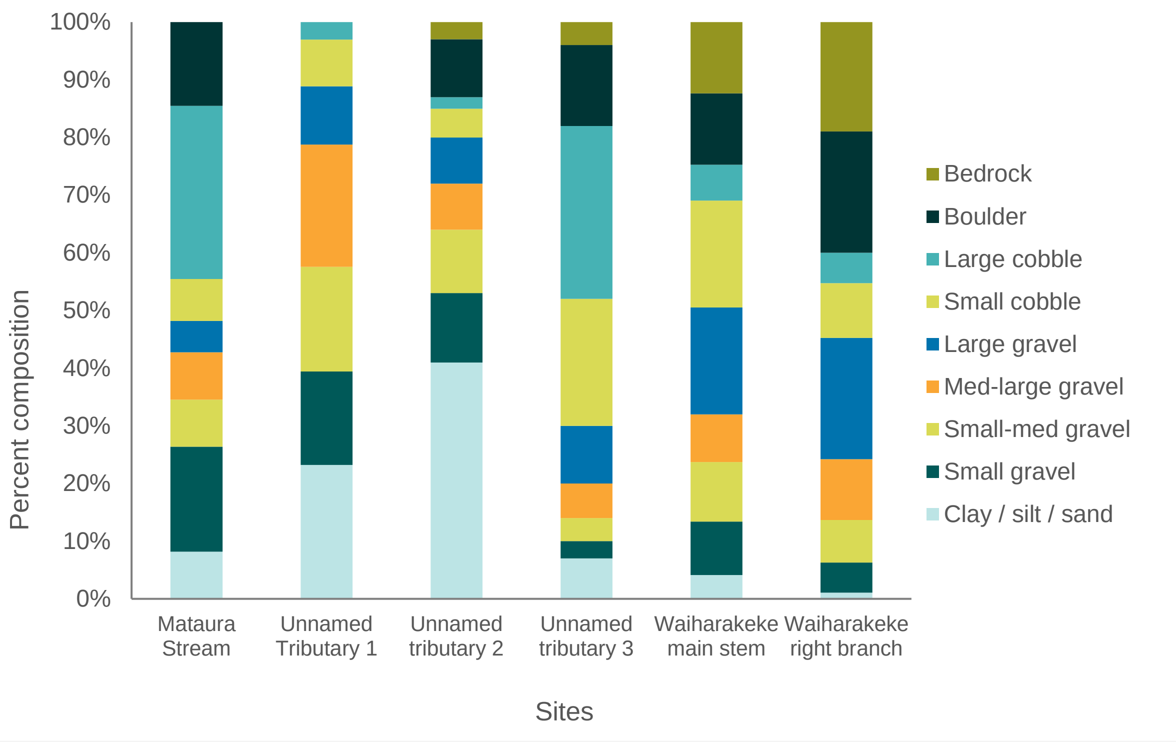


Figure 7: *Sediment particle size for Waiharakeke Stream, Mataura Stream and Tributary 2 and 3 of the Mataura Stream catchment.*

7.1.42 Macroinvertebrate Assemblages

The macroinvertebrate assemblage within the Mataura Stream was made up largely of Dobson flies (*Archichauliodes*), snails (*Potamopyrgus*), riffle beetles (Elmidae) and caddisflies

(*Hydropsyche, Aoteapsyche*). With the exception of snails, which occur in a large range of water quality and habitat types, the remaining species listed above are largely only found in moderate to good water / habitat quality.

Tributary 1 macroinvertebrate community was dominated by the true flies (*Austrosimulium*), oligochaete worms and *Potamopyrus* snails. The *Potamopyrus* snails can be found in pristine to poor-quality streams or within poor water / habitat quality (i.e. they are tolerant of poorer water quality and habitat conditions).

Tributary 2 macroinvertebrate assemblage was made up of oligochaete worms, springtails (Collembola), and true flies (*Austrosimulium* and Orthocladiinae).

The macroinvertebrate assemblage with Tributary 3 was predominantly made up of single gill mayfly (*Deleatidium*) which are indicators of good habitat and water quality conditions. Snails and Chironomid midges (Orthocladiinae) were also present which are often abundant in unshaded, nutrient-enriched streams with prolific algal growths.

The Mataura Stream had a diverse range of EPT taxa, with *Aoteapsyche* notably abundant, and which is indicative of reasonable water quality and instream habitat. Tributary 1 contained a low range of EPT taxa, which was primarily comprised of the mayfly *Zephlebia* and the caddisfly *Oxyethira*. Tributary 2 contained a comparatively reduced range of EPT taxa and most of the species richness was made up of low abundance of caddisflies (*Hydrobioisis*, *Costachorema*, *Pycnocentria* and *Oxyethira*). Tributary 3, like Mataura Stream, had a diverse range of EPT taxa, with the *Deleatidium* being notably abundant.

The MCI and SQMCI scores for the Mataura Stream were both indicative of “moderate” water and/or habitat quality. The MCI score for Tributary 1 and Tributary 2 is considered ‘fair’ and suggests “moderate” water and/or habitat quality, while both SQMCI scores suggest severe organic pollution or nutrient enrichment (NPS-FM, 2020)[13]. Tributary 3 had a macroinvertebrate community indicative of mild to moderate organic pollution or nutrient enrichment.

Appendix 2B of the NOF provides for the preparation of attributes requiring action plans and include attribute bands for the MCI and QMCI. We acknowledge that our results represent a single survey, but the results indicate that Mataura Stream falls into Attribute band C, while for Tributary 1 MCI is within band C, but SQMCI is below NBL. Tributary 2, the MCI shows the watercourse is in Attribute band C, but falls below the NBL for QMCI (Table 13).

[13] Interpretation of the classification of MCI and QMCI scores is provided in Table 3-3 of Appendix 3 of this report.

Table 13: *Summary of macroinvertebrate metrics from the Mataura Stream catchment and comparison with NOF.*

Metric	Site			
	Mataura Stream (July 2020)	Tributary 1 (July 2020)	Tributary 2 (January 2021)	Tributary 3 (January 2023)
Taxonomic richness	26	29	27	24
No. of EPT taxa	13	6	5	12
Percent EPT	50	21	19	50
MCI	109.2	96.6	84.4	118
SQMCI	5.4	3.2	3.7	4.8
MCI NOF Action Plan Attribute Band#	Band C	Band C	Band D (Below NBL^)	Band B
SQMCI NOF Action Plan Attribute Band#	Band C	Band D (Below NBL^)	Band D (Below NBL^)	Band C

#Attributes requiring action plans are provided for by the NOF (NPSFM, Chapter 2B).
^NBL = National Bottom Line.

7.1.43 Fish Communities

Within Tributary 2 shortfin eels were captured (size range from 300 – 500 mm in length). In addition, a fish species (suspected *Galaxias* species) was also observed. Shortfin eel has a conservation status of not threatened (DOC 2018a). Several kōura (*Paranephrops planifrons*) were also caught during electric fishing; we note that kōura are listed as non-threatened (DOC 2018b).

Within Tributary 3 only shortfin eel were captured during surveys across three SEV sites.

Annual fish surveys are conducted in Mataura Stream as part of OGNZL's permit to discharge treated water to the Ohinemuri River. The survey site is located within the same (or slightly adjacent) reach where this assessment was conducted. Fishing methods include three passes using an electric fishing machine and is similar to methods outlined in Joy et al. (2013). Over the past four monitoring occasions, four native fish have been identified; shortfin eel, longfin eel, Crans bully and common bully. Longfin eel are classified as *At Risk* (declining). In addition, kōura have been captured as well as the introduced rainbow trout (*Oncorhynchus mykiss*).

There are also five records from the freshwater fish database for the Mataura Stream (these records appear to be separate to the annual monitoring records). Kōaro was the only other species recorded in addition to those already identified from the annual monitoring. There were 14 records from adjacent catchments (Walmsley Stream, Ratarua Stream and Ohinemuri River reach between the confluence of these two streams), which also identified banded kokopu and the introduced brown trout (*Salmo trutta*). We consider all the species identified from the annual monitoring, as well as from the freshwater fish database (including adjacent catchments), to be present within the Mataura Stream. Kōaro have a conservation status of At Risk (declining).

Fish IBI is provided in Table 14. The rating of 'excellent' fish IBI rating for the Mataura Stream means that the fish species present were as expected for the attributes of the location (i.e. distance from the coast, altitude). Notwithstanding the existing weir downstream in the Ohinemuri River, there appear to be no barriers preventing climbing fish reaching the Mataura Stream. The fish IBI for Tributary 2 is 'fair' reflecting the more degraded nature of the catchment and the potential for barriers to fish access.

Table 14*: Summary of fish IBI scores from Mataura Stream catchment.*

Assessed site	IBI score	Rating
Mataura Stream	58	Excellent
Tributary 1	20	Fair
Tributary 2	20	Fair
Tributary 3	22	Fair

7.1.44 Stream Ecological Valuation

The overall SEV score for Tributary 2 was 0.594, indicating impaired function within the sampling reach. No SEVs were undertaken in the Mataura Stream.

The Tributary 1 reach scored highest for natural flow regime and connectivity groundwater, with a natural channel with bed or bank linking. The reach scored poorly for riparian vegetation and associated factors such as shade and filtering.

The Tributary 2 reach scored high for connectivity to natural species migrations, natural connectivity to groundwater and natural flow regime, which were all greater than 0.75. Most of the assessment is only based on the assessed reach so any wider issues within the tributary, are not accounted for within the assessment. The reach scored particularly poorly for organic matter input and riparian vegetation intact (both less than 0.10), which is due to the lack of riparian vegetation.

Tributary 3 score is the mean of the three SEV assessments that were undertaken (range 0.51-0.62). Overall, the tributary scored high for natural flow regime, and connectivity to groundwater. Shade was low-moderate, with higher shading in the northern reach, predominantly from stream banks. However, the riparian margin, and associated attributes, scored low as there was very little riparian vegetation.

A summary of the SEV data is provided in Appendix 5.

Table 15*: Summary of SEV scores from Mataura Stream catchment.*

Assessed site	SEV score
Tributary 1	0.46
Tributary 2	0.59
Tributary 3	0.58*

Note*: SEV minus FFI and IFI; Mean of 3 survey sites.

Although prepared for a different purpose, WRC (2020) convey a range of SEV scores throughout the Waikato region, including rural streams; we note that the SEV score for tributary 2 is placed within the range reported for low intensity agricultural streams. Although a different region, we note that overall SEV score was similar to examples of rural stream scores within the Auckland region (AC 2011).

7.1.45 Summary of Ecological Values

In this section we provide an overview of the components used to determine the ecological values of the assessed aquatic features, summarised in Table 16. The assessed reach of Mataura Stream has good instream habitat quality and quantity consisting of an array of different habitats, including, riffles, runs, pools, undercut banks and overhanging / encroaching vegetation. Sediment cover was minimal with some sediment build up in slower flowing or more sheltered areas. Macroinvertebrate assemblages and indices were reflective of the good-quality habitat with many sensitive taxa. Fish species richness was diverse with six native fish species recorded within the stream or in adjacent catchments. Riparian vegetation and stream shading were limited and included mostly rank pasture and low stature vegetation. There did not appear to be any level of modification to the stream channel within the assessed reach, however the riparian margin was highly modified. We have assessed the Mataura Stream reach as comprising **High** ecological value.

Tributary 2 has good instream habitat quality and moderate quantity consisting mostly of riffles habitat and also featuring pools, runs, occasional waterfalls, undercut banks, overhanging / encroaching riparian vegetation and root mats from mostly low stature riparian vegetation. While habitat may have been diverse, these habitats were not abundant. Sediment cover across the stream was low, but there was higher cover in reaches with lesser gradients. Macroinvertebrate assemblages and indices were reflective of the habitat. Fish species richness was low with only shortfin eel detected, likely due to the fish barrier downstream and the impaired habitat quality of the reach. Riparian vegetation and stream shading were limited and included mostly rank pasture and low stature vegetation along most of the reach. However, there was more established vegetation within the upper reaches where stock was not able to access due to the steepness of the banks. Stream modification along the reach was moderate with numerous culverts for stock crossing (including a perched culvert), erosion and bank slumping from stock access, limited riparian vegetation and a constructed online pond. We have assessed Tributary 2 as comprising **Moderate** ecological values.

Tributary 1 and Tributary 3 are very similar in nature to Tributary 2 as described above and have been assessed as comprising **Moderate** ecological values.

Table 16: *Summary of ecological values of Mataura Stream catchment.*

EIANZ Criteria					
Site		Mataura Stream	Tributary 1	Tributary 2	Tributary 3
Ecological value		High	Moderate	Moderate	Moderate
Metric	Native fish species	Shortfin eel, Longfin eel, Crans bully, Common bully, Koaro, Banded kokopu	-	Shortfin eel	Shortfin eel
	Presence of invasive macrophytes	None	-	Low (water celery, reed sweetgrass and water starwort)	None
	SQMCI	5.4 (Good)	3.2 (Poor)	3.2 (Poor)	4.8 (Good)
	Fish IBI	58 (Excellent)	20 (Fair)	20 (Fair)	22 (Fair)
	Sediment & water quality	Fair	-	Fair	Good
	Sediment cover	Minimal	Fair	Low	Low
	Riparian (stream) cover	Low	Low	Low	Low
	Macroinvertebrate taxonomic richness	26	29	29	24
	Instream habitat quality & quantity	High	Moderate	Moderate	Good
	Percent EPT taxa	50	21	21	50
	SEV score	-	0.46	0.594	0.58*
	Existing stream modification	Minimal	Moderate	Moderate	Moderate

8.0 Services Trench

8.1.1 Introduction

A buried services trench connecting the Willows Road Farm to the existing Waihi Plant will carry power, fibre optic cables and treated / potable and recycled water. The route follows Willows Road corridor to SH25, west of SH25 to west of Ohinemuri Bridge then overland to the Processing Plant, predominantly on OGNZL-owned land (Figure 8).

The proposed services trench is some 4.56 km in length but has a narrow trenching requirement (2.5 m).

A site walkover was carried out in the proposed services trench footprint to assess ecological values on 11 November 2021, with further visits in May and September 2023. The route followed largely road verge and grazed pasture and includes river crossings. Vegetation comprises exotic species including grey willow, poplar and barberry with mixed pasture grasses along the route. Vegetation clearance will be minimal as the trench is narrow (2.5 m maximum width).

Here we describe the key freshwater and wetland features along the route of the services trench.

8.1.2 Aquatic Features Along the Proposed Services Trench Route

8.1.3 Methods

The NPS-FM and NESF require specific assessments of wetlands to determine their status and extent. Methods followed the wetland delineation protocols referenced in the NPS-FM.

Surveys were undertaken on 11 November 2021. Rainfall in the preceding month of October had been above normal for the Coromandel (120% - 149%) and ground conditions at the time of the survey were moist to saturated. Follow up surveys were undertaken in May and September 2023 to assess the potential wetland feature at Site 2. These surveys included the January 2023 amendments to the NPS-FM that included a specification of ‘pasture species’ which excludes any FACW or OBL plants, and an additional protocol to assess whether the pasture exclusion applies (Ministry for the Environment, 2022b).

8.1.4 Wetlands along the proposed services trench route

Six prospective “natural inland wetland” features were identified along the proposed services trench alignment (Figure 8) (below existing powerlines) in the November 2021 site walkover (Appendix 13). Follow up surveys were undertaken in May and September 2023 to assess the potential wetland feature at Site 2. Photographs and further descriptions of prospective features are also included in Appendix 13.

In summary:

- **Site 1** is a shallow water body with floating aquatic macrophytes. It meets the "rapid test" but is excluded as it is a constructed feature (an excavated pond).
- **Site 2** is a flow path surrounded by an area of saturated ground (grazed and pugged), vegetated with exotic grasses (predominantly creeping bent, a FACW species) and actively managed for stock grazing. A visual assessment was sufficient to confirm that the flow path meets the "rapid test", and does not meet any of the exclusions, and therefore meets the definition of a natural inland wetland. The area of saturated ground was further assessed and a map of the wetland is provided in Appendix 13.
- **Site 3** is an area of standing water surrounded by creeping bent and interspersed with patches of water pepper (obligate). While vegetation cover was sparse, it met the "rapid test", but is excluded as a constructed feature (a shallow excavated pond).
- **Site 4** is a well-defined channel containing standing or slowly flowing water. The November 2021 survey (undertaken during an unseasonably wet spring) noted thick floating mats of exotic FAC pasture grasses, mainly Yorkshire fog, along with meadow grass (*Poa trivialis*) and paspalum (*Paspalum dilatatum*), interspersed with clumps of rushes (*Juncus canadensis, J. effusus)*. Vegetation cover at this site meets the pasture exclusion, while the channel itself meets the definition of an intermittent stream.
- **Site 5** is a well-defined, deeply incised tributary with no hydrophilic vegetation, and does not meet any of the wetland delineation tests.
- **Site 6** is an area of grazed exotic grassland dominated by pasture species (including FAC and FACU species). Small patches of FACW and OBL species are locally present, but not dominant, in low-lying parts of the site. Vegetation comprises more than 50% pasture species and it does not meet the definition of a natural inland wetland.

The prospective wetland at Site 2 was reviewed by WWLA (2023), who based on the hydrology and soil substrate, concluded that the area through which the service trench will be excavated is not a wetland; rather it is an overland flow path that conveys water down to the lower terrace adjacent to the Ohinemuri River. WWLA go on to state that any effects on the identified feature from excavating the trench through the already disturbed area will be less than minor with respect to the hydrologic and hydrogeological regime and will be of limited duration.

These assessments give conflicting views on whether it truly is a natural inland wetland. However, given inherent uncertainties and ambiguity of definitions we have taken a precautionary approach and have considered the feature to meet the definition of a natural inland wetland.

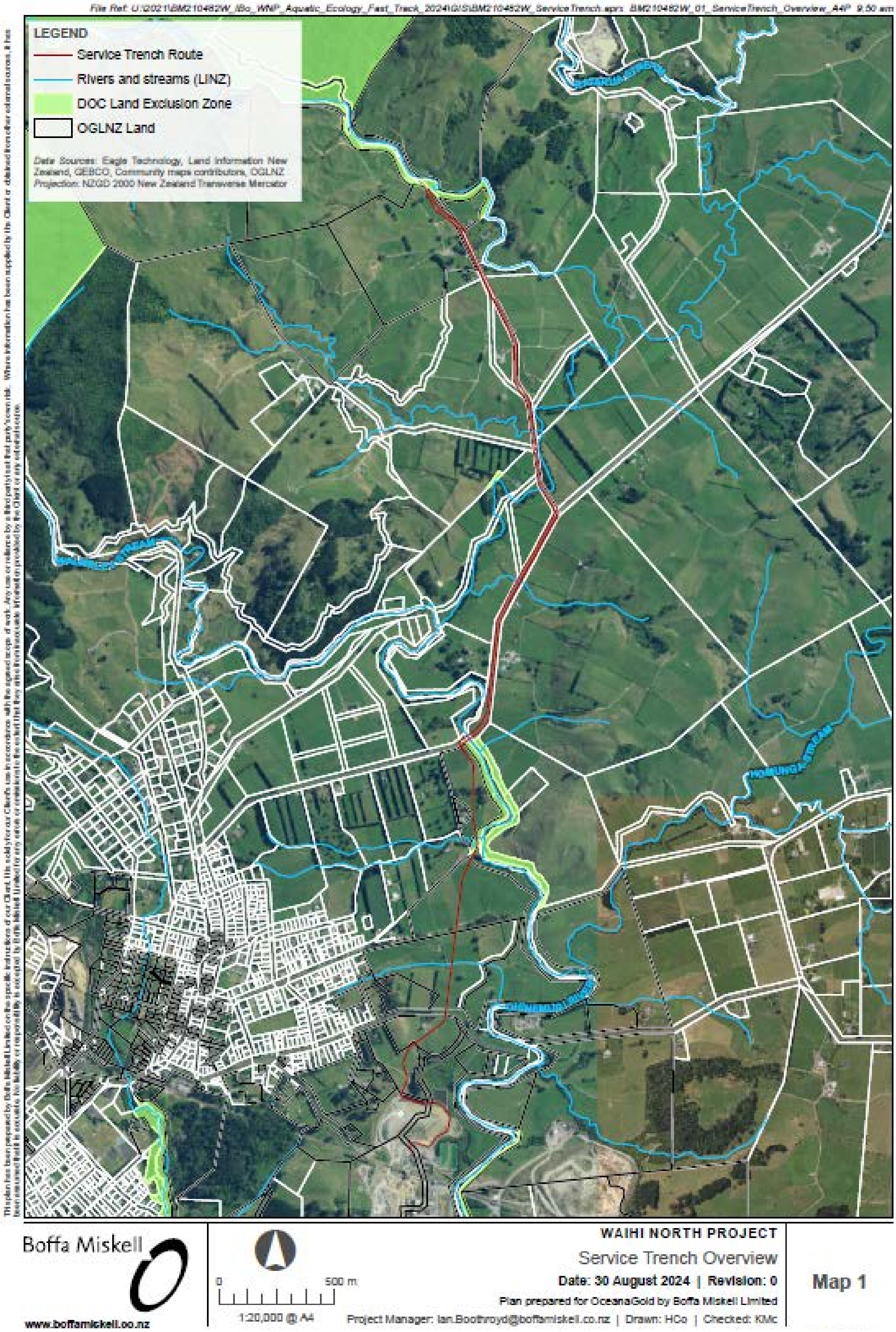


Figure 8: *Route of the proposed services trench.*

8.1.5 Watercourses

For the most part the services corridor crosses streams and rivers at existing bridges, including the Ohinemuri River at two locations. The service corridor crosses two unnamed tributary streams as it approaches the Waihi operations. No aquatic surveys have been undertaken of these two streams, but they were visually assessed as part of the corridor walkover as the services will utilise the bridge infrastructure with no disturbance to the stream or its banks. However, for completeness we note:

- Tributary a (Site 4), a shallow stream feature approximately 5 m wide. The channel was completely covered in grasses and thick floating grass mats.
- Tributary b (Site 5), an entrenched watercourse running alongside a barberry hedge with a bank height of some 0.5 m.

No specific surveys or assessments have been carried out on the Ohinemuri River at the two locations where the services will cross. Instead, we have relied on the monitoring and assessments that have been carried out on the Ohinemuri River as a result of monitoring of the treated water discharge into the river. We note that the upper sampling location for that monitoring programme is upstream in the vicinity of the proposed SH25 crossing.

8.1.6 Favona wetland

The Favona wetland is located to the north of the WTP and alongside the true right bank of the Ohinemuri River. As it is a prominent feature, here we provide a summary of the ecological values of the feature.

By way of summary, the Favona wetland is modified by apparent historical clearance, earthworks and modification to drainage patterns. Parts of this wetland feature have been revegetated by OGNZL, notably with dense plantations of flax (*Phormium tenax*) planted in places. Large swards of *Carex* species (*C. geminata*, *C. secta* and *C. virgata*) cover much of the channel of the wide, shallow watercourse (which is most likely a naturally occurring channel), with local patches of *Machaerina rubiginosa*, *Elaeocharis acuta* and kiokio (*Blechnum novae-zelandiae*) in boggy areas of shallower, standing water (these appear to be naturally established). Copses of young matai trees (approximately 1.5 – 2 m tall) have also been planted around the northern and western margins of the feature, while a few large pines (*Pinus radiata*), and clumps of mixed native and exotic scrub, are present on surrounding hillslopes.

The Favona wetland has significant ecological value, and the wetland meets the significance criteria of the WRPS although it is noted that the status is partly derived from the restoration of the wetland undertaken by OGNZL (and its antecedent companies) from what appears to have previously been an exotic, willow-dominated wetland[14], to an indigenous species-dominated wetland. The willows would have been removed through a catchment flood management initiative in the 1980s and we understand that the area was subject to drill and fill around 2006.

The Favona wetland meets the definition of a natural inland wetland of the NPS-FM and is subject to the provisions of the NESF.

We emphasise that, at all times, the services trench avoids earthworks within 100 m of Favona wetland.

[14] This assessment is based on a review of older satellite imagery.

9.0 Gladstone Open Pit

9.1.1 Introduction

The proposed Gladstone Open Pit (GOP) will be situated predominantly over Gladstone Hill and part of Winner Hill. The Processing Plant is located immediately to the east of the pit and the Martha Pit conveyor is directly to the north. Land use comprises rolling farmland and pastures, with a small pine plantation to the southwest. The Ohinemuri River is located approximately 300 m southwest of the GOP.

The pit will disturb an area of approximately 23.2 ha, will be about 95 m deep (1005 mRL), 375 m wide and 625 m long. The pit will be mined using conventional open pit mining methods.

The GOP aspect of the WNP involves open pit mining from development and production through to closing of the pit as a tailings storage facility. The pit will be mined over a period of approximately six years and conversion of GOP into a TSF will commence thereafter. No tailings will be discharged into the GOP until the production from the Martha Underground (MUG) operation has ceased.

9.1.2 Gladstone Open Pit Project Activities

Mining of GOP comprises:

- Pre-stripping of topsoil from the pit footprint and storage at Southern stockpile (capacity: 52,500 m^3);
- Relocating the existing Favona portal and associated infrastructure within GOP or north of the conveyor adjacent to the proposed WUG Portal;
- Installing a new crusher and interconnecting conveyor for transporting rock to the NRS;
- Establishing a new Portal “WUG Portal”;
- Hauling and storing ore and/or rock at the existing polishing pond stockpile, if required; and
- Construction of noise bunds or screens around the pit rim, where required.

The pit comprises 2.6Mt of ore and 18.7Mt of waste rock. Selected topsoil material will be stockpiled adjacent to the pit at the Southern Stockpile. Waste rock from the GOP will be removed from this location and stored initially at the existing central and eastern stockpile areas adjacent to the existing TSFs.

For closure, approximately 5.0Mt of rock will be required for partial backfilling of the pit. The rock required for backfilling will be transported across the Ohinemuri River from the NRS by reversing the existing overland conveyor. The remaining void will be used for tailings storage.

All discharges will be directed either to the collection ponds located close to the Favona amenities buildings or direct to the WTP.

Clean water diversion drains will be installed around the pit perimeter, lined either with HDPE or shotcrete if necessary and these will discharge directly to the nearby minor water courses to which surface runoff is currently reporting. It may also be possible to direct discharge clean water to the Ohinemuri River from dewatering holes in the upper parts of Gladstone pit provided that they do not have elevated metals or high TSS or TDS levels.

9.1.3 Ecological Values

9.1.4 Headwater Gully

Gully Characteristics

The area of the proposed pit encompasses the headwaters of a tributary gully of the Ohinemuri River, which leads to a restored wetland in the lower reaches (Gladstone Wetland). We note that the Gladstone wetland downstream is largely fed by the water table at that location, rather than from the tributary gullies feeding into it (see below). Nevertheless, during intensive rain periods, the tributary gully likely provides an incidental input to the Gladstone wetland downstream. We investigated this tributary gully for any additional water sources and walked most of the length of the reach above Gladstone wetland to ascertain if any wetland features occurred in the headwaters. Seepages were observed at the time of our assessment, and wet ground and pools of water were noted approximately 200 m below the access road at the head of the gully. The headwater gully is not and does not comprise of natural wetland features.

The watercourse contains mostly sections of well-defined channel and sections of dry terrace where no channel is evident. Much of the reach was dry at each of our site visits, other than short sections of well-defined channel that contained some pools. These areas occurred below the opening of a former mine adit that seeped water along a short contributing channel.

Hydrological Characteristics

GWS (2021) considers the hydrogeological aspects of the headwater gully and its relationship with the downstream Gladstone wetland. Catchment rainfall runs off the steep slopes where it goes to soakage mid-slope forming interflow. Interflow only occurs following rainfall and the rate of discharge is governed by the steepness of the topography and the permeability of the soils. Some rainfall infiltration passes though the ash / regolith and enters the shallow groundwater system that forms the permanent water table.

The interflow drains down slope under gravity and discharges into the incised headwater gully channel and only occurs after prolonged periods of rainfall (i.e. measured in days) (GWS 2021). The mine adit is not considered to contribute discharge to the headwater gully due to it being above the permanent water table elevation (GWS 2021).

We classified the headwater gully as an intermittent watercourse.

Vegetation Characteristics

All vegetation surrounding the headwater gully is planted. A dense 5 – 10 m wide buffer of manuka and kanuka surrounds the watercourse, while the channel and immediate surrounds contain a simple mix of wetland plants (*Carex secta, C. lessoniana*, harakeke and cabbage trees). Stands of harakeke and *Carex* were generally noted as somewhat sparse and unthrifty, probably due to the heavy shade cast by the tall, dense kanuka canopy that covers all but the immediate area above the channel. No naturally established wetland species or “wet tolerant” plants were observed. Soil profiles showed a thin layer of clay over a lower layer of dark, friable soil and an upper layer which may have been imported topsoil. No hydric soil indicators were observed (Figure 9, Figure 10).

In the lower reaches where the gully levels out, this has also been revegetated and is comprised of dense swards of *Carex virgata* interspersed with discrete patches of giant umbrella sedge, a small amount of *Machaerina* spp., as well as kiokio and other common ground ferns including water fern (*Histiopteris incisa*) and gully fern (*Pneumatopteris pennigera*). Also present are some patches of blackberry and exotic herbs. These patches are then surrounded by riparian plantings dominated by flax on the margins and then a dense buffer of kānuka, mānuka and broadleaved shrubs.

Habitat

The Gladstone headwater gully contained a sequence of defined stream channels and flatter riparian areas, with the sequence repeated down watercourse until it intersects with the Gladstone wetland. The channel varied in width from 0.35 – 0.8 m within the stream areas and 0.6 – 8.0 m within the flatter riparian benched areas. Water velocity was slower within the wider and flatter wetland areas. No pools were present within the stream channel habitat. The stream bed was dominated by silt/sand with some bedrock and small pieces of wood also present. Macrophytes were not present along the stream reach.

Macroinvertebrate Communities

A macroinvertebrate sample was obtained from one of the water pooling areas within the headwater gully. Fifteen macroinvertebrate taxa were recorded from the headwater gully feature. No EPT taxa were present. The most abundant taxa were Collembola (springtails) which accounted for 57% of all individuals present. Collembola are not a truly aquatic species but are common along stream margins where they feed on plant detritus. The chironomid midge *Polypedilum* was the next most abundant taxa accounting for 25% of all individuals present. These midges are found in streams of widely varying water quality where they often burrow into soft plant matter.

The MCI-sb score for the headwater gully was 91 which is indicative of 'Fair' water quality and habitat characteristics (Stark and Maxted 2007).

Fish Populations

Electro-fishing was undertaken within the small pools within the upper headwater gully sample reach. No fish species were observed or collected during the survey.

Stream Ecological Valuation

The SEV assessment undertaken at Gladstone headwater tributary resulted in a score of 0.617, which is indicative of a 'good' quality habitat. The individual attribute scores are provided in Appendix 5.

Figure 9: *Gladstone headwater gully and Gladstone wetland. ARD = acoustic recording device*

Figure 10: *Gladstone headwater gully vegetation and soil profile.*

Assessment Against NPS-FM

We do not consider that the revegetated headwater gully meets the definition of a natural wetland, because it does not contain areas of wet ground (other than in the well-defined channel). Areas of wet-tolerant vegetation are planted on benches (i.e. not naturally established) and hence is not a "natural" ecosystem of plants. Accordingly, the NESF regulations relevant to wetlands do not apply to the Gladstone headwater tributary.

Ecological Values

The Gladstone headwater gully has no features that meet the significance threshold under the RPS Section 11A criteria and the stream values are of moderate ecological value (Table 17).

Table 17: *Summary of ecological values of the Gladstone headwater gully.*

EIANZ criteria	
Site	**Gladstone Headwater Tributary**
Ecological value	**Moderate**
Reasons for our assessment	• Invertebrate community has moderate diversity. • Invertebrate community dominated by detritus eating taxa. • MCI score of 91 • No EPT taxa • SEV score of 0.617 • No fish present • Stream channel and banks unmodified, well established restored riparian

9.1.5 Gladstone Wetland

Vegetation Characteristics

The Gladstone wetland contains substantial areas of raupō and *Carex geminata*, and local patches of giant umbrella sedge (probably naturally established), surrounded by a wide perimeter of dense flax interspersed with cabbage trees (Figure 9,Figure 11). The Gladstone wetland is not listed as an SNA in the HDP.

However, the Gladstone wetland meets the WRC significance criteria based largely on the restoration of the wetland from what appears to have been an exotic, willow-dominated wetland, to an indigenous plant dominated wetland. Photographs of Gladstone wetland are shown in Figure 11.

Hydrological Characteristics

GWS (2021) describes the Gladstone wetland as an expansive, flat section from around 92 mRL to 90 mRL with the length of the wetland having only a few meters fall. At the downslope end of the wetland, there is an earth embankment and culvert after which there is an approximate 2-3 m drop down to the Ohinemuri River.

GWS (2021) goes on to describe the location of the wetland as an area of unstable ground formed due to repeated failures at the ash / regolith contact with the underlying volcanic geological layer. These materials are relatively porous and accumulation of water at the interface of the geologic units is the main destabilising mechanism. The pre-existing environment was likely one of wet ground. At some stage in the 1960s a farm track was constructed as a raised earth embankment with a culvert to allow surface water through flow. This earthwork essentially dammed the valley resulting in an area of standing water developing. Over time, the wetland developed naturally and since the mid 2000's it was actively restored as a wetland by OGNZL (and its antecedent owners).

GHD (2022C) has developed a conceptual assessment of the wetland hydrology. Flow from the catchment to the wetlands and drainage of stored water from the wetlands, which influences water levels and wetland drying, occurs via different modes and at different rates, creating a flow and water level recession response. The outcomes of this are not uniformly evidenced within the wetland and tributary, primarily owing to differences in wetland elevation. The wetland provides both a path for overland flow and dynamic storage for water which flows to the tributary and the Ohinemuri River.

Monitoring at the outlet from the wetland at the earth embankment and culvert (Site TB4 in GHD 2022C), shows that there are periods of no discharge from the Gladstone Wetland:

- Summer 2019 – not flowing for approximately 1 day on 2 occasions.
- Summer 2020 – not flowing for approximately 5 months.
- Summer 2021 – not flowing for approximately 2 weeks.

Conceptually, GHD (2022C) envisages the wetland response as follows:

- Significant rain events create rapid catchment run-off and saturation of soils and organic litter within the wetland. Excess water is rapidly passed through the wetlands, as high rates of surface water flow and high-water levels. Residual water, whether ponded or in wetland soils or litter, remains as stored water within the wetland.
- Delayed flow from the catchment, such as from interflow, continues after rapid run-off has ceased. This continued inflow maintains effective saturation of the wetland. The catchment inflow reduces over a period of days to weeks since rainfall.
- Water stored within the wetland drains from soils and organic litter at a slower rate than surface water flow. Water drains from the upper wetland areas towards lower parts of the wetland, where it contributes surface water flow in lower parts of the wetland and in the tributary, maintaining a higher degree of saturation in these areas.
- The drainage of stored water is buffered by groundwater inflow to the wetland, any residual interflow from the catchment and any subsequent inflow created by rain events. The rate of drainage from wetland soils exceeds the rate of groundwater inflow.
- During dry periods, sub-surface drainage continues to remove stored water, with greater reductions in stored water in the upper areas of the wetland first. Prolonged periods without rain see this ongoing drainage result in drying of the wetland, first at the upper wetland extents, and ultimately in lower areas, including at the tributary.
- The occurrence of no-flow or dry conditions at the tributary coincides with that point in time when the rate of drainage from the wetlands has reduced to the point that it can be passed as groundwater flow beneath the tributary culvert i.e. there is no excess to generate surface water flow.

- Re-saturation of the wetland is readily achieved by rainfall after a drought period.

It is expected that when the tributary is dry, the wetland itself can be considered to have minimal standing water i.e. the wetland may also have dry parts. However, during such times the soil moisture within the wetland may still remain high.

Gladstone Wetland Avifauna Values

To better understand the habitat value and wetland bird species using the Gladstone wetland a site survey was undertaken (2 November 2017) which included a site walkover and deployment of an ARD. Of the 15 species of birds recorded over 10 consecutive days by the ARD deployed at this site (Table), five were native species and 10 exotic species. No ‘At Risk’ or ‘Threatened’ bird species were detected. Incidental observations made during the site walk over (Table 18) detected a subset of those detected by the ARD.

The Gladstone wetland contains suitable habitat for a number of wetland bird species and although no ‘At Risk’ or ‘Threatened’ bird species were detected during surveys, the RPS refers to underrepresented habitat including wetlands as having high ecological values: “It is indigenous vegetation, habitat or ecosystem type that is under-represented (20% or less of its known or likely original extent remaining) in an Ecological District, or Ecological Region, or nationally” (WRC 2016).

Figure 11: *Vegetation characteristics at Gladstone wetland.*

Table 18: *Bird species observed and/or recorded at Gladstone wetland 2018.*

Bird Species	Incidental observations	ARD
Fantail	✓	✓
Grey warbler	✓	✓
Kingfisher	✓	✓
Silvereye		✓
Pukeko	✓	✓
California Quail		✓
Greenfinch	✓	✓
Chaffinch	✓	✓
Rosella		✓
Blackbird		✓
Myna		✓
House sparrow		✓
Skylark	✓	✓
Pheasant		✓
Spotted dove		✓

Ecological Values

The ecological values of the Gladstone wetland are summarised in Table 19.

Table 19: *Summary of ecological values of Gladstone Wetland.*

EIANZ criteria	
Site	**Gladstone Wetland**
Value	**Moderate**
Reasons for our assessment	• Large (1.0 ha), high quality wetland restoration located downstream of the proposed Gladstone pit (Wetland Gladstone Pit Downstream). • Assessed as having significant ecological value based on criteria in the RPS. • Good connectivity to other wetland features in the landscape, with potentially high value habitat for Threatened/At Risk marsh birds. • Sequence of small wetland patches along the restored tributary that feeds the main wetland. • Small tributary watercourse has moderate ecological function. • Assessed using the EIANZ criteria a having moderate ecological value.

10.0 Tailings Storage Management

10.1.1 Introduction

10.1.2 Tailings Storage Facility (TSF3)

A new Tailings Storage Facility (TSF3) is proposed to provide the tailings storage for the WNP in addition to that provided by the proposed GOP TSF. TSF3 is a downstream earth and rockfill embankment structure, like TSF1A and 2, and forms an impoundment to store the discharged tailings slurry pumped from the Processing Plant.

The total footprint of TSF3 is approximately 115 ha. Of this area 20 ha is already part of the existing footprint of TSF1A and Eastern Stockpile. The new proposed footprint of TSF3 is therefore 95 ha.

10.1.3 Ecological Values

10.1.4 Ruahorehore Stream

Catchment Characteristics

The Ruahorehore Stream is a large catchment of some 2,000 ha. A sub-catchment of some 20 ha runs southeast to northwest through the proposed TSF3 site to discharge into the Ohinemuri River east of Waihi township. Land use in the catchment is predominantly pastoral and although the mainstem appears to follow its original course, large areas of the surrounding catchment have been drained with artificial channels. The constructed farm pond, originally a constructed silt pond developed as part of the TSF1A construction programme, now provides a source for stock watering.

Habitat Characteristics

With the exception of the headwaters, this sub-catchment of the Ruahorehore Stream is characterised by an incised channel of varying width (0.17 - 3.3 m) and depth (0.2 - >1 m), and substrate comprised largely of silt / sand with occasional small gravels and bedrock present. Riparian vegetation is absent along much of its length, although parts in the lower reaches of the Ruahorehore Stream have been subject to planting by OGNZL (see section 4). Bank slumping is evident along much of the stream length, with areas of pugging from stock also present. Macrophytes were often abundant, particularly along the stream edges including the emerged species willow weed and mercer grass (*Paspalum distichum*) and the submerged species *Elodea canadensis* and *Nitella sp*.

The headwaters of the sub-catchment (site RUA-forest) is located within a regenerating forest area, upstream of other survey sites (Figure 12). The stream channel is predominantly comprised of large boulders, with a mixture of pools, runs, cascades and waterfalls present. No macrophyte species were present at this site and bank erosion was absent. Vegetation within the riparian zone is dense with black tree fern (*Cyathea medullaris*) the dominant species, with some remnant mature pine trees present.

Further detail of the habitat characteristics of the Ruahorehore Stream sample sites is provided in Appendix 4.

Benthic Macroinvertebrates Characteristics

The macroinvertebrate assemblages within the Ruahorehore Stream varied along its length with varied taxa number and macroinvertebrate abundance. Macroinvertebrate communities were generally similar, but the uppermost forested site was notable for a greater dominance of EPT taxa, with the stonefly *Acroperla* (33 individuals) and the mayflies *Arachnocolus* (27 individuals) and *Coloburiscus* (26 individuals). The presence of the two mayflies in such abundance is an indicator of high habitat and water quality. In contrast, the lower reaches were dominated by other species such as *Oxyethira* and the snail *Potamopyrgus antipodarum*.

MCI-sb scores in the Ruahorehore Stream varied between 74 (RUA_lower) and 115 (RUA_forest). Water and habitat quality as assessed using macroinvertebrate indices thus varied between good in the upper reaches to poor in the lower reaches[15].

As detailed above, Appendix 2B of the NOF provides for the preparation of attributes requiring action plans and include attribute bands for the MCI and QMCI. We acknowledge that our results represent a single survey, but the results show that the upper Ruahorehore Stream falls within Attribute band B, while the lower Ruahorehore Stream is below the national bottom line in band D for the (Table 20).

Further detail on the macroinvertebrate communities of the Ruahorehore Stream is provided in Appendix 5.

Table 20*:* *Summary of macroinvertebrate metrics from the Ruahorehore Stream catchment along with comparison with NOF.*

Site	RUA_Lower	RUA_Upper	RUA_Forest	RUA_Trig Road	RUA_Revegetated
Taxonomic richness	17	23	22	34	32
No. of EPT taxa	4	8	7	7	10
% EPT taxa	23.5	34.8	31.8	4.8	51.4
MCI	74.1	110	115	80	83
SQMCI	3.24	4.5	6.13	2.13	2.37
SEV	0.435	0.532	0.85	0.403	0.575
MCI NOF Action Plan Attribute Band#	Band D (Below NBL^)	Band B	Band B	Band D (Below NBL^)	Band D (Below NBL^)
QMCI NOF Action Plan Attribute Band#	Band D (Below NBL^)	Band C	Band B	Band D (Below NBL^)	Band D (Below NBL^)

#Attributes requiring action plans are provided for by the NOF (NPSFM, Chapter 2B). ^NBL = National Bottom Line.

[15] Interpretation of the classification of MCI and QMCI scores is provided in Table 3-3 of Appendix 3 of this report.

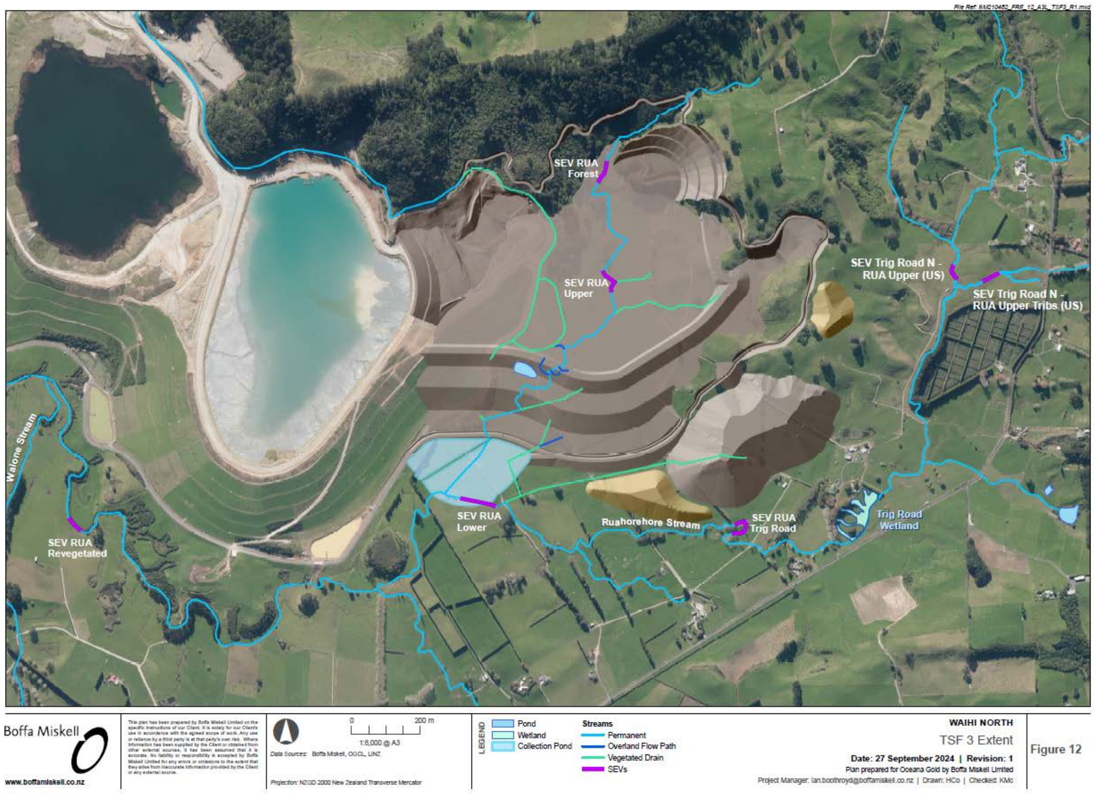


Figure 12: *Ruahorehore Stream at TSF3.*

Fish Communities

Fish populations present at site RUA_revegetated contained an abundance of common bully (n= 90). Shortfin eel and kōura were also present.

Fish populations at site RUA_lower had an abundance of shortfin eel with at least 30 individuals present: predominantly living amongst the macrophytes. Kōura, a common bully and a rainbow trout (*Oncorhynchus mykiss*) were also present.

Site RUA_upper was home to a large longfin eel over 1.1 m in length. Longfin eel are classed as At Risk – Declining (DOC 2018a). In addition, three shortfin eels and five kōura were present.

Kōura were abundant at site RUA_forest with over 60 individuals recorded. A longfin eel and a shortfin eel were also recorded. A waterfall located between site RUA_upper and site RUA_forest represents a significant barrier to fish passage of swimming species.

Fish populations at site RUA_Trig Road were poor with only shortfin eel recorded.

Stream Ecological Valuation

SEV scores ranged from 0.4 (RUA_Trig_Road) to 0.85 (RUA_Forest), thus ranging from poor to excellent stream functionality. As might be expected SEV scores were highest in the upper catchment and scores were lowest in the lower catchment, including the Trig Road site (RUA_Trig_Road).

Two SEV surveys (excluding biotic functions) were undertaken on potential mitigation sites in the upper reaches of the Ruahorehore Stream (sites TRN_RUA, Figure 12). These surveys returned scores of 0.42 on the main stem and 0.31 on the tributary. These low scores were driven primarily by a lack of riparian vegetation or shading, high erosion and sediment in the main steam and recent channel clearance in the tributary.

The key driver of the SEV is the presence of riparian vegetation as well as the retention of more natural attributes notably within the forested and upper sections of the stream. As for the SEV descriptions for the Mataura Stream catchment, the SEV scores for the Ruahorehore Stream occur within the range reported for forested and rural streams (WRC 2020, AC 2011). The individual SEV attribute scores for each site are provided in Appendix 5.

Vegetated Drains Ruahorehore

Numerous drains intersect the farmland within the proposed tailings and rock disposal area. These drains contain substantial volumes of flowing water, and evidently work to lower the water table sufficiently to have enabled pastoral conversion of wetlands likely to have been once present throughout areas of low-lying land. The margins of these drains are predominately vegetated with rank grass, exotic herbs and exotic trees and shrubs including: Spanish heath, pampus, blackberry, gorse, Chinese privet and crack willow. The incised stream banks however are generally well-vegetated in native ferns such as wheki (*Dicksonia squarrosa),* kiokio, ring fern (*Paesia scaberula*) and bracken (*Pteridium esculentum*).

These vegetated drains provide habitat to freshwater macroinvertebrate and fish species, functioning in a similar manner to natural streams. In particular, these drains provide fish passage from the Ruahorehore Stream to the forested headwaters of the sub-catchment.

10.1.5 Summary

The freshwater ecological values across the Ruahorehore Stream catchment are varied with a mixture of permanent waterways, vegetated drains and water collection ponds (Table 21). The Ruahorehore Stream, both adjacent to and downstream of the proposed TSF3 is a highly modified habitat of generally moderate-poor quality. Riparian vegetation is limited (except at site RUA_forest within the SNA) with excessive macrophyte growth common. The macroinvertebrate communities present are diverse with the pollution sensitive EPT taxa present at all sites, but communities are dominated by those species that are more pollution tolerant.

Ecological values of the Ruahorehore Stream within the proposed TSF3 footprint are of moderate (RUA_Upper) and high (RUA_Forest) ecological value. Diverse macroinvertebrate and fish communities are present and include the presence of kōura and longfin eel (At Risk – Declining).

10.1.6 Significance of Freshwater Ecological Values

The permanent upstream tributary of the Ruahorehore Stream within the TSF3 footprint meets the significance criteria within the RPS Section 11A in particular meeting criterion 3:

(3) It is vegetation or habitat that is currently habitat for indigenous species or associations of indigenous species that are:

- Classed as threatened or at risk, or
- endemic to the Waikato Region, or at the limit of their natural range.

This criterion was satisfied through the presence of longfin eel, an At Risk – Declining, species being present at both sites RUA_upper and RUA_forest. Site RUA_forest is also located within a SNA (T13UP166 – based on terrestrial characteristics) within the HDP.

Table 21: *Summary of ecological value of the Ruahorehore Stream (based on EIANZ criteria). The SEV surveys for TRN_RUA_Upper and TRN_RUA_UP_Trib_US did not include assessment of the biotic functions.*

	Within Footprint			Outside Footprint	
Site	**RUA_Lower**	**RUA_Upper**	**RUA_Forest**	**RUA_Trig Road**	**RUA_Revegetated**
Ecological Value	**Medium**	**Medium-High**	**Very High**	**Medium**	**Medium**
Ecological Values Metric	Invertebrate community has moderate abundance and diversity Dominated by pollution tolerant taxa MCI score of 74.1 4 EPT taxa 3 fish taxa present SEV 0.435 Stream channel has excessive sediment loads and banks are collapsing. No riparian vegetation	Invertebrate community has low abundance and moderate diversity No dominant taxa MCI score of 110 8 EPT taxa 2 fish taxa present including At Risk longfin eel SEV 0.532 Stream channel reasonably unmodified, some bank erosion No riparian vegetation	Moderate taxa diversity Community dominated by EPT taxa MCI score of 115 7 EPT taxa 2 fish taxa present including At Risk longfin eel SEV 0.85 Stream channel natural Native riparian vegetation with closed canopy	Moderate abundance and high diversity Dominated by pollution tolerant taxa MCI score of 80 7 EPT taxa 1 fish taxa present SEV 0.403 Stream channel has excessive sediment loads and banks are collapsing. Riparian exotics, no canopy closure	Invertebrate community is abundant and diverse Moderately dominated by pollution tolerant taxa MCI score of 83 10 EPT taxa 2 fish taxa present SEV 0.575 Stream channel has excessive sediment loading and banks are collapsing Riparian restoration on TRB
Site				**TRN_RUA_Upper**	**TRN_RUA_Up_Trib_US**
Ecological Value				**Low**	**Low**
				SEV 0.42 Stream channel has areas of excessive sediment. Active bank erosion Riparian	SEV 0.31 Stream channel cleared, deepened. Riparian long grasses, rare weedy shrub.

11.0 Surplus Rock Management (Northern Rock Stack)

11.1.1 Introduction

The Northern Rock Stack is planned to contain up to 7 million cubic metres of material and is constructed to a nominal height of RL 173 m. Also proposed are topsoil stockpiles, two of which are constructed at the northern extent of the Company owned land and adjacent to Golden Valley Road.

11.1.2 Ecological Values

11.1.3 Background

The proposed footprint of the NRS encompasses a significant portion of the stream ‘TB1’, its tributaries and associated features (Figure 13). We note that TB1 is an existing formed diversion resulting from an earlier expansion of the mining operations at Waihi. To better understand the freshwater environment within the NRS footprint, two SEV surveys were undertaken within the two dominant stream habitat types within the footprint. Site TB1_lower was located on the main TB1 Stream some 200 m upstream of the confluence with the Ohinemuri River and was chosen for its representativeness of the TB1 Stream. Site TB1_upper was located upstream on a tributary to the TB1 stream and was selected for its representativeness of the stream habitats within the eastern extent of the NRS footprint. Habitat characteristics of the TB1 stream are provided in Appendix 4. In addition, a former constructed silt pond that has since been rehabilitated and naturally recolonised occurs in the mid-reaches of TB1.

11.1.4 Habitat

Site TB1_lower had a reasonably wide (1.7 – 3.4 m) channel with a predominantly silt / sand substrate with the occasional small gravel present. Water flow was slow, with large and deep pools (up to 1.26 m deep) present along the reach and some areas of anoxic sediment. Riparian vegetation had been planted to approximately 10 m either side and fenced off from the surrounding grazed pasture. Native species such as flax, lemonwood, cabbage tree and mapou have been planted, amongst others. The giant umbrella sedge is abundant along the stream edge on both banks, with it extending out to several meters towards the downstream end of the reach. Small areas of active erosion were present along the reach, with bank slumping more apparent at the downstream end of the reach.

Macrophytes were rare along the survey reach, with small areas of *Nitella sp*. present along the survey reach. At the downstream end of the reach the stream channel shallowed and concentrated patches of watercress and water purslane (*Ludwigia palustris*) were present.

Site TB1_upper had a narrow stream channel (0.4 – 0.9 m) with channel incision resulting in comparatively high stream banks (0.5 – 1.0 m). The stream channel was predominantly silt / sand, with some small gravel and patches of bedrock also present. Riparian vegetation was limited, with overhanging pasture grass, Juncus effusus, fern species and Japanese honeysuckle (*Lonicera japonica*) present. The stream and two metres of the riparian zone are fenced off from stock access. Isolated patches of bank slumping were present along the reach.

Macrophytes were common along the reach with mercer grass (*Paspalum distichum*) present along most of the reach, with small patches of watercress and starwort (*Callitriche stagnalis*) also present.

11.1.5 Macroinvertebrate Communities

Macroinvertebrate communities at the two sites sampled in TB1 had similar macroinvertebrate communities. Lower TB1 was dominated by the amphipod *Paracalliope* and the upper site by the snail *Potamopyrgus antipodarum*. EPT taxa present included the double gill mayfly (*Zephlebia*), the free-living caddis (*Polyplectropus*), the stick caddis (*Triplectides*), and the pollution tolerant axehead caddis (*Oxyethira*). Other taxa present included, amongst others, damselfly, flies, crustaceans and flatworms.

The MCI-sb scores for the TB1 ranged from 82.3 to 93.6, both indicative of 'Fair' quality (Stark and Maxted 2007).

11.1.6 Fish Populations

Fish populations at TB1 were similar at both TB1 sample sites with only the shortfin eel (*Anguilla australis*) observed during the survey. Site TB1_lower had no apparent fish barriers from the confluence with the Ohinemuri River. Some 150 m downstream of site TB1_upper was a large natural waterfall that would have posed a significant natural fish barrier to swimming fish species.

11.1.7 Stream Ecological Valuation

The SEV assessment on site TB1_lower returned a value of 0.501, while site TB1_upper returned a value of 0.409; both of which are indicative of 'moderate' quality habitat. The individual attribute scores are listed below in Appendix 5.

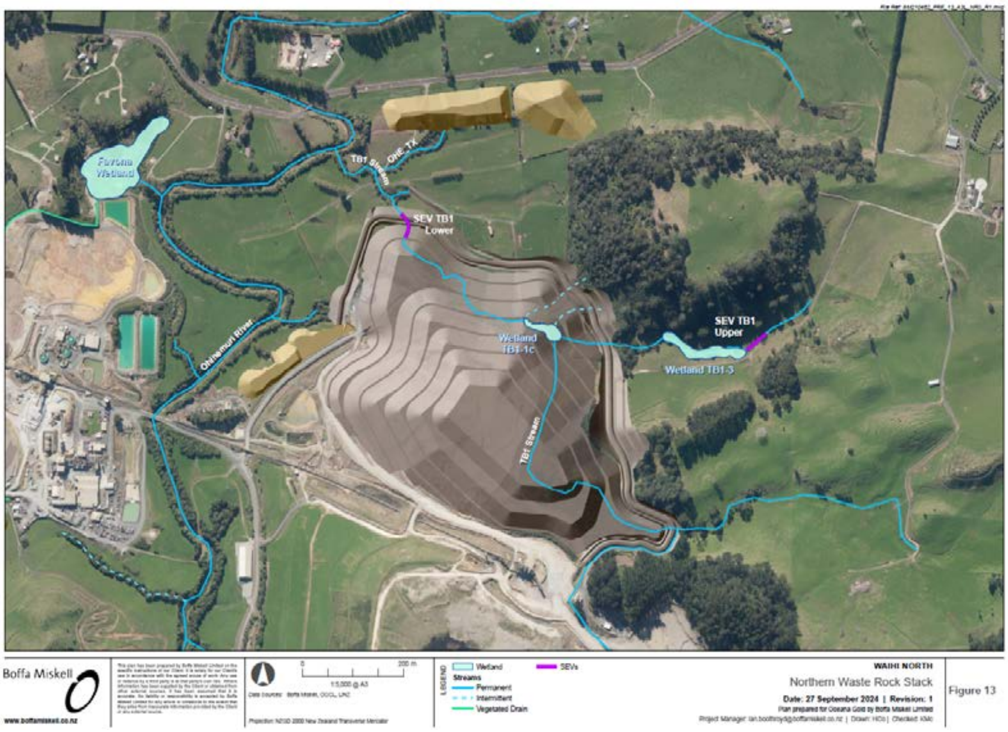


Figure 13: *Tributary TB1, Northern Rock Stack.*

11.1.8 TB1 Wetland Feature

A wetland feature occurs within the TB1 stream corridor at TB1-1c. This wetland has been formed from a former silt pond that was developed as part of the construction of the tailings storage facility (TSF2). The relevant resource consents for diversions and silt ponds for the North of TSF2[16] do not require a rehabilitation to a constructed wetland. In addition, nowhere in the OceanaGold Waihi Extended Project AEE (Waihi Gold 1997) is there any mention that wetlands would be affected by the project, and accordingly there is no mention of any requirement to offset impacts on, or to restore an existing former wetland. The planting of the decommissioned silt pond at TB1 is part of the OGNZL's predecessor Company's commitment to "beyond compliance" outcome as opposed to it being a requirement to offset impacts on or restore an existing or former wetland.

This feature is not a natural inland wetland, as described in the NPSFM, because it is a deliberately constructed wetland as part of a re-routed watercourse and arising from a former created silt pond[17.]

11.1.9 Summary

Overall, streams within the NRS footprint are considered to be of moderate ecological value. The streams are historically highly modified with streambeds smothered by fine sediment; partially a result of their predominantly pasture catchments. Macroinvertebrate communities were dominated by pollution tolerant taxa, while the presence of EPT taxa was relatively low. The fish fauna was sparse, with only shortfin eel species recorded during the surveys.

11.1.10 Significance of Freshwater Ecological Values

The streams within the NRS footprint are not considered significant under the RPS Section 11A criteria.

11.1.11 EIANZ Ecological Value

The tributaries within the NRS footprint were classified using the EIANZ criteria outlined in and we consider both sites to have 'medium' ecological value (Table 22).

16 Water permit 971296 to divert natural water (farm run-off and intercepted groundwater) around the oxidised stockpile N2 at the northern end of Storage 2, water permit 971298 to divert natural an unnamed tributary (Unnamed Stream 2) of the Ohinemuri River at the northern end of Storage 2, water permit 971299 to divert part of an unnamed tributary (Unnamed Stream 1) of the Ohinemuri River by way of culverting at the northern end of Storage 2, and discharge permit 971311 to discharge settled stormwater from site ponds within Area D.

17 NPS-FM Subpart 3, 3.21 Definitions relating to wetlands and rivers: natural inland wetland (b) a deliberately constructed wetland.

Table 22: *Summary of ecological values of locations within NRS footprint and surrounds.*

Within the Footprint	Outside of Footprint
TB1_Lower	**TB1_Upper**
Medium	**Medium**
• Invertebrate community has moderate diversity and low abundance. • MCI score of 82.3 • Four EPT taxa present • SEV score of 0.501 • Shortfin eel present • Stream channel and banks unmodified, well established restored riparian vegetation but no canopy closure.	• Invertebrate community has low diversity and abundance. • Invertebrate community dominated by pollution tolerant sp. • MCI score of 93.6 • Four EPT taxa present • SEV score of 0.409 • Shortfin eel present • Stream channel and banks modified through vegetation removal and stock access.

12.0 Indigenous Biodiversity Significance

12.1.1 Introduction

The RPS sets out the criteria for identifying areas of significant indigenous biodiversity and their characteristics as they exist at the time the criteria are being applied[18] (WRC 2016). Criteria[19] may be specific to a habitat type including water, land or airspace or be more inclusive to address connectivity, or movement of species across habitat types. The criteria are provided in Appendix 1.

The significance of ecological habitat within the proposed project footprint was evaluated using the 'Criteria for determining significance of indigenous biodiversity' in Section 11A of the RPS. This criteria states that "*To be identified as significant an area needs to meet one or more of the criteria identified in the table below*" (i.e. in Table 11-1 of the RPS (Appendix 1)).

12.1.2 Freshwater Indigenous Biodiversity Significance

When assessed against the RPS significance criteria (Section 11A, see Appendix 1), the ecological attributes of Mataura Stream and Ruahorehore Stream meet significance criterion 3 and criterion 9:

3. It is vegetation or habitat that is currently habitat for indigenous species or associations of indigenous species that are:

- classed as threatened or at risk, or
- endemic to the Waikato region, or
- at the limit of their natural range.

9. It is an area of indigenous vegetation or habitat that is a healthy and representative example of its type because:

18 Section 11A Indigenous Biodiversity.

19 Table 11-1 Criteria for determining significance of indigenous biodiversity.

- *its structure, composition, and ecological processes are largely intact; and*
- *if protected from the adverse effects of plant and animal pests and of adjacent land and water use (e.g. stock, discharges, erosion, sediment disturbance), can maintain its ecological sustainability over time.*

The Mataura Stream provides habitat to two At Risk – Declining fish species being longfin eel and koaro. Accordingly, the Mataura Stream is assessed as significant for indigenous biodiversity. None of the remaining freshwater ecosystems within the WNP project area were assessed as significant for indigenous biodiversity.

12.1.3 Wetland Indigenous Biodiversity Significance

The Willows Road Farm wetland contains two mature swamp maire trees which have been classified as 'Threatened – Nationally Critical', although we acknowledge that this is a precautionary measure based on the uncertainty surrounding myrtle rust. However, swamp maire is noted as being rare within the Waihi Ecological District (Kessels & Associates 2010).

No other wetlands in the WNP project area meet the criteria as significant for indigenous biodiversity.

13.0 Water Treatment Plant Reconsenting

13.1.1 Introduction

The Waihi North Project will utilise the existing WTP to treat water from the mining operations. The Waihi North Project will not result in any different types of water requiring treatment and water being conveyed to the WTP for treatment will continue to come from across the Waihi Epithermal District.

OGNZL holds resource consents that provide for the discharge of treated water from the WTP to the Ohinemuri River via multi-port diffusers at two consented locations ("WTP Discharge Consent"). The current WTP Discharge Consent authorises the discharge of treated water into the Ohinemuri River under five different operating regimes, with each operating regime containing specific controls in relation to discharge volume, rate, the percentage of discharge relative to river flow and discharge quality.

GHD (2022A) concluded that, based on the water balance analysis completed, it is predicted that the Waihi North Project can be implemented using the existing and upgraded WTP functionality, and within the current consent discharge and receiving environment conditions, subject to renewal of those consents for an appropriate term. The capacity of the current WTP facilities will require upgrading throughout the project's lifetime to cope with the expected volume of water requiring treatment.

No changes to the water quality limits from the discharge from the WTP are required to accommodate the Waihi North Project. Nevertheless, in this section we consider the various guidelines for water quality applicable to the Ohinemuri River, and the effectiveness of the existing water quality criteria provided for in the respective guidelines and resource consents on the ecological values of the Ohinemuri River. In section 19, we go on to consider the appropriateness of retaining the existing instream water quality criteria for the protection of instream ecological values.

13.1.2 Water quality guidelines

13.1.3 National Policy Statement Freshwater Management 2020 (NPSFM)

The NPS-FM came into effect in September 2020. As outlined in Section 5.1.2 above, the NPS-FM requires regional councils, through their regional plans, to set freshwater objectives that provide for freshwater values, and to set water quality limits and develop management actions to achieve those objectives.

The NPS-FM identifies ‘attributes’ to assist regional councils in developing numeric objectives for rivers and lakes, as well as policies (including limits) for achieving those objectives. ‘Attributes’ are the ‘measurable characteristics of freshwater, including physical, chemical and biological properties which supports particular values.’

13.1.4 United States Environmental Protection Agency (USEPA) 1986.

The USEPA (1985, 1986) guidelines were used to derive water quality standards for the acceptability of the final treated water discharge to the Ohinemuri River (consent number 971318).

13.1.5 WRC

WRC water quality criteria consider three categories for ecological health: excellent, satisfactory and unsatisfactory (Appendix 6). These are based on ‘critical values’ for seven water quality variables identified as relevant to the suitability of river water for ecological health:

- dissolved oxygen
- pH
- turbidity
- ammonia
- temperature
- total phosphorus
- total nitrogen.

13.1.6 Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG) 2018

ANZG (2018) provide water managers and regulators with tools and guidance to assess, manage and monitor water quality. ANZG guidance provides detailed approaches and advice on identifying appropriate guideline values for selected indicators. These guideline values help to ensure that agreed community values and their management goals are protected.

ANZG (2018) state that for the protection of aquatic ecosystems, locally derived guideline values are most appropriate. In the absence of locally derived guideline values or other jurisdictionally-legislated requirements, ANZG (2018) provide Default Guideline Values (DGVs) for some community values for use in both Australia and New Zealand, as well as advice on tailoring DGVs to suit a local region.

13.1.7 Water quality and ecology of the Ohinemuri River catchment

13.1.8 Background

There have been several programmes and reports detailing the water quality and ecology of the Ohinemuri River. The commencement of silver and gold mining within the catchment in the 1980s after a period of relative inactivity in mining in the area resulted in a number of baseline assessments of potential impacts reports on the water quality and ecological condition of the river (e.g., Bioresearches 1997) and many reports on the annual biological and water quality compliance monitoring (e.g., Golder 2016, 2017, 2018, Ryder 2019a, 2020, 2021). This information provides useful historical baseline information.

The most relevant, recent, and long-term water and ecological monitoring programmes are held and reported by OGNZL (annual compliance monitoring since 1987), NIWA (National Rivers programme), and the WRC State of the Environment monitoring. These programmes have been established to achieve different purposes, and each is described briefly below. All of the programmes include sampling water quality and ecological attributes of the river.

It is not our intention to summarise and repeat all of the data from these monitoring programmes; such data is well reported and will be referenced accordingly. However, we draw on the data available, particularly the OGNZL compliance monitoring data, to inform our discussion on the water quality and ecology of the Ohinemuri River.

13.1.9 NIWA National River Water Quality Network (NRWQN)

NIWA undertakes a national water quality and ecological sampling programme of some 77 sites on 35 rivers around the country. Sites were selected so that a national perspective of state and trends of water quality could be developed. On most rivers there are two or more sites representing an upstream ‘Baseline’ site (lightly impacted) and a downstream ‘Impact’ site (reflecting the impacts of humans on water quality). A single site on the Ohinemuri River is sampled at the Karangahake Gorge. The NIWA programme measures the following water quality parameters:

- Physico - chemical variables: dissolved oxygen, temperature, pH, conductivity
- Optical variables: Visual clarity, turbidity, coloured dissolved organic matter
- Nutrients: Total and dissolved forms of nitrogen and phosphorus
- Microbial Indicator: *E. coli* (since 2005).

13.1.10 WRC State of the Environment Water Quality Monitoring

WRC undertakes monthly State of the Environment (SoE) monitoring of river and stream sites throughout the region[20]. Four sites are listed for the Ohinemuri River:

- Ohinemuri River at the SH 25 Bridge (upstream of OGNZL site)
- Ohinemuri River at Queen's Head (downstream of the OGNZL site)
- Ohinemuri River at Waikino (downstream of the OGNZL site and Queens Head, downstream of confluence with the Waitekauri River)
- Ohinemuri River at Karangahake Gorge (downstream of OGNZL site, but upstream of the Waitawheta River).

Water quality data from the past five years from three sites is summarised below and forms the primary data for discussion on the water quality of the Ohinemuri River.

WRC measures a range of factors (such as water clarity, temperature, nutrients) to enable an overall assessment and to classify the water quality condition as excellent, satisfactory or unsatisfactory for:

- Ecology – supporting plants and animals that live in water.
- Swimming – people can fully immerse themselves in the water.

13.1.11 Summary of Water Quality of the Ohinemuri River catchment

Water quality data from NIWA and Waikato Regional Council is reported on the Council website[21]. Summary data from the last of the selected water quality parameters are provided in Table 23.

LAWA[22] reports the water quality of the Ohinemuri River at SH25 and Karangahake Gorge (respectively upstream and downstream of the existing treated water discharge) as within Attribute band A NPSFM attribute state for ammoniacal nitrogen, DRP and nitrate nitrogen and trends were indeterminate or improving (especially total phosphorus). Note that at the Queens Head and Karangahake sites (downstream of the OGNZL site), the LAWA site reports ammoniacal nitrogen (annual median) as meeting NOF Attribute band B, with a degrading trend at the lowest catchment site. DRP was in NOF DRP Attribute band A at all sites within the Ohinemuri River. LAWA report *E. coli* as NOF Attribute band D (for human contact in lakes and rivers) at all four sites within the Ohinemuri River[23].

For the most part water quality variables met the WRC 'Excellent' category for the physico-chemical components (pH, dissolved oxygen) of water quality within the Ohinemuri River. Not all attributes monitored by WRC are the equivalent of those used in the NPS categories listed

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[20] https://www.waikatoregion.govt.nz/environment/natural-resources/water/rivers/healthyrivers/

[21] https://www.waikatoregion.govt.nz/environment/natural-resources/water/rivers/water-quality-monitoring-map-and-sites/

[22] www.lawa.org.nz/explore-data/waikato-region/river-quality/waihou-river

[23] Attribute D = 20-30% of the time, the estimated risk is >=50 in 1000 (>5% risk). The predicted average infection risk is >3% (The predicted average infection risk is the overall average infection to swimmers based on a random exposure on a random day, ignoring any possibility of not swimming during high flows or when a surveillance advisory is in place (assuming that the E. coli concentration follows a lognormal distribution). Actual risk will generally be less if a person does not swim during high flows.)

but the median value for total phosphorus suggests at least satisfactory quality (WRC water quality categories).

Water quality within the Ohinemuri River has elevated levels of Nitrogen (satisfactory – unsatisfactory) but lower levels of phosphorus (~satisfactory-excellent). Biological indicators of water quality (cf; periphyton, MCI and QMCI) show a poor to moderate water quality condition of the Ohinemuri River at Waihi, and indicative of moderate nutrient enrichment (LAWA[24], Golder 2017), mostly resulting from land use activity within the catchment.

For the Ohinemuri River monitoring site at SH25 upstream of Waihi township, LAWA show MCI (five-year median of 90.3) as within Attribute band C of the NOF requiring action plans, and Attribute D for QMCI (five-year median of 4.36); Attribute D is below the National Bottom Line for ecosystems health condition.

13.1.12 OGNZL Treated Water Discharge Monitoring

13.1.13 Background

OGNZL holds a discharge permit (Discharge Permit 971318) to discharge treated water into the Ohinemuri River (at two locations). The water is treated in a Water Treatment Plant (WTP) prior to being discharged into the river through an 'upper' (E1) and/or 'lower' (E2) discharge (Figure 14). At times the mine can also discharge water from TSF2 into an unnamed tributary of the Ohinemuri River.

Condition 16 of Discharge Permit 971318 specifies the collection of water samples from sites within the Ohinemuri River and Ruahorehore Stream, while Condition 17 of the same consent requires the reporting of results to WRC. The resource consent also included conditions which set out the receiving water quality standards that are to be met. These water quality limits are provided in Appendix 6 and are discussed further in Chapter 20 of the present report.

Accordingly, OGNZL undertakes a range of long-term receiving water biological, sediment and water quality monitoring. Monitoring is undertaken at nine sites; five of which are located on the Ohinemuri River and four are located on tributaries to the Ohinemuri River. The purpose of the data collection is to measure compliance with the water quality standards set within the conditions of the resource consent.

Of the sites on the Ohinemuri River, one is located upstream of all mine related discharges (OC2), one is located downstream of the tributary into which TSF2 discharges but upstream of discharge E1 (OH3), two are located between discharge E1 and E2 (OH5 and OH1) and one is downstream of all mine related discharges (OH6).

As for the above, it is not our intention to summarise and repeat all of the data from the consent monitoring programmes; such data is well reported and will be referenced accordingly. However, we summarise the lengthy record of OGNZL compliance monitoring data to inform our discussion on the water quality and ecology of the Ohinemuri River at Waihi.

[24] https://www.lawa.org.nz/explore-data/waikato-region/river-quality/waihou-river/ohinemuri-river-at-sh25-br-mci_swq/

13.1.14 Heavy Metals

The existing discharge consent monitoring requires that heavy metals are sampled and measured and assessed against the limits detailed in the consent conditions, which are derived from USEPA (1986) criteria. The historical range from the collective OGNZL monitoring sites for each parameter, including sediments, is provided in Table 24.

Ryder (2021) concludes that in-river metals were below compliance limits (USEPA criteria) and often below detection limit. Similar conclusions were reported in earlier compliance reports, Golder (2015a, 2016) and Ryder (2018-2020). Ryder (2021) notes that selenium trigger limit requires concentrations remain below 0.02 g/m3 97 % of the time on an annual basis and are not permitted to exceed 0.035 g/m3 in any single analysis. We note that the laboratory detection limit[25] for mercury is higher than the consented compliance limit. Historical range derived from data measured May 2005 to May 2021.

[25] Laboratory detection limit = the minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results.

Table 23: *Summary statistics for water quality at selected sites along the Ohinemuri River and relevant water quality guidelines 2013-2018. Data provided courtesy of WRC. Data shows median values, with range in parentheses, followed by the number of samples (n). All units g/m^3 except where otherwise stated.*

Site	SH25	Queen's Head	Karangahake Gorge	NPSFM Attribute Band (for rivers)[^]	WRC Water Quality Categories[$]
Sample period	01/2013-01/2018	01/2013-01/2018	01/1994-02/2015		
Dissolved Oxygen	10.5 (8.8-11.7), n=61	10.4 (8-13) n=61	10.3 (9.7-10.8) n=6	A=>8.0 NBL=5.0	E=>90% S=80-90% U=<80%*
pH (pH units)	7.2 (6.4-7.8), n=61	7.1 (6.7-8.3) n=61	7.2 (7.0-7.8) n=6		E=7-8 S=6.5-7 or 8-9 U=<6.5 or >9
Turbidity (NTU)	1.04 (0.55-41), n=61	1.1 (0.4-16.6) n=61	1.48 (0.74-2.1) n=6		E=<2 S=2-5 U=>5
Ammonia (NH4)	0.023 (0.01-0.049), n=61	0.071 (0.011-0.29) n=61	0.03 (0.015-0.037) n=6	A=<0.03 B=>0.03-<0.24 NBL=0.24	
TKN	0.13 (0.06-1.02), n=61	0.25 (0.09-0.79) n=31	0.19 (0.13-0.28) n=6		
TON (NNN)	0.45 (0.067-0.97), n=61	0.95 (0.042-1.84) n=61	0.68 (0.182-0.84) n=6		
Total Phosphorus	0.011 (0.004-0.162), n=13	0.01 (0.004-0.076) n=61	0.009 (0.004-0.011) n=6		E=<0.01 S=0.01-0.04 U=>0.04
DRP	0.005 (0.004-0.031), n=61	0.005 (0.004-0.015) n=61	0.0045 (0.004-0.005) n=6	A=<0.006[C]	

[#] Default trigger levels for physical and chemical stressors in New Zealand for slightly to moderately disturbed ecosystems (ANZECC, 2000); [$]E=Excellent, S=Satisfactory, U=Unsatisfactory. [$] For Dissolved oxygen the WRC guidelines are expressed in percent saturation, and the monitoring results as g/L. The conversion of empirical units to percent saturation for dissolved oxygen in water is dependent on the water temperature and elevation at the site. However, median dissolved oxygen levels of >10 g/L would be expected to be >90% saturated and therefore be in the Excellent category. See Appendix 6 for critical values.
^ NPSFM 2020. Attribute Bands A to D; NBL=National Bottom Line. [C] Attributes requiring action plan.

Table 24: *Historical range (2005-2021) for heavy metals recorded at OGNZL monitoring sites in the Ohinemuri River in the vicinity of OceanaGold Waihi, Waihi. Data from sites OC2, OH3, OH5, OH1, OH6, RU1 and drawn from Ryder (2021), see Figure 10 for site locations. All units g/m3;< = below detection limit; HD = hardness dependent*[26.]

Parameter	Min	Max	Compliance limits
Antimony	<0.0002	0.026	0.03
Arsenic	<0.0002	0.0046	0.19
Cadmium	<0.00005	0.00007	HD
Copper	<0.0005	0.0031	HD
Iron	<0.02	0.64	1.00
Lead	<0.0001	0.0013	HD
Manganese	0.0011	0.88	2.00
Mercury	<0.00008	0.0001	0.000012
Nickel	<0.0005	0.0058	HD
Selenium	<0.0002	0.0095	0.02
Silver	<0.00001	0.0015	HD
Zinc	<0.001	0.055	HD

[26] Generally, as hardness increases, the toxicity of metals decreases.

Figure 14: *Sampling sites and treated water discharge locations, Ohinemuri River and Ruahorehore Stream (From GHD 2022B).*

13.1.15 Ecological Condition of the Ohinemuri River at Waihi

13.1.16 Background

The ecological condition of the Ohinemuri River in the vicinity of the Waihi mining operation is best informed by the consent monitoring undertaken by OGNZL. As described above, the monitoring programme is comprehensive and requires that habitat, algae, macroinvertebrates and fish are surveyed at regular intervals. The most recent survey data is provided in Ryder (2021) but reports on baseline studies and regular monitoring extend back to 1983. We have not attempted to summarise all of the previous information here; rather we have drawn on the most recent monitoring data, as well as data from the WRC SOE monitoring programmes to inform our discussion on the condition of the Ohinemuri River at Waihi.

13.1.17 Macroinvertebrates

Macroinvertebrate metrics – upstream in the Ohinemuri River at SH25 (1994-2021)

We have used the WRC SOE macroinvertebrate monitoring data to highlight the ecological condition of the Ohinemuri River upstream of Waihi. The ecological condition of the Ohinemuri River catchment at the SH25 site upstream of Waihi shows considerable variation over the 23-year record as recorded from the WRC state of the environment monitoring programme (Table 25). In recent years the condition of the river, as measured by the Macroinvertebrate Community Index (MCI), has been poor-fair, and this is reflected in the results of the OGNZL in-river biological monitoring (see below and Table 26). The increase in taxa number represents a shift in the community composition to a more tolerant fauna, largely dominated by dipteran flies and worms[27].

Macroinvertebrate metrics – OGNZL monitoring

Summaries of the macroinvertebrate biological indices (MCI and QMCI) for each of four monitoring sites in the Ohinemuri River undertaken by OGNZL (OH3, OH5, OH1 and OH6) for the period 2003-2021 are shown in Figure 15 and Figure 16. The results reflect the poor/fair condition of the river discussed above, as measured by these metrics.

Over this longitudinal study (2003 – 2021) the mean MCI was 81.3 (Fair), this score increased during the spring season by an average of 4 points ($F1, 1198 = 83.23$, $p < 0.001$). Differences were also found between years ($F18, 1181 = 13.93$, $p < 0.001$), however no apparent trend was observed (linear regression; $R2 = 0.008$). QMCI results also showed an increased value in spring ($F1, 1198 = 13.87$, $p < 0.001$) and fluctuated throughout the sampling time period ($F18, 1181 = 58.31$, $p < 0.001$). However, no trend was observed (linear regression; $R2 = 0.11$). We note that the MCI values recorded as below a score of 90, or QMCI scores below 4.5 would be below the National Bottom Line provided for by the NPS-FM (2020).

[27] It is worth noting that some of the variance in the metrics will have come from different levels of taxonomic penetration of the macroinvertebrate sample data.

Table 25: *Summary statistics for macroinvertebrate samples from the Ohinemuri River at SH25, 1994-2021. Data provided courtesy of Waikato Regional Council.*

Sample Date	Taxa number	Abundance#	EPT	%EPT abundance	MCI[28]
Dec-94	13	100	7	73	110
Dec-95	9	100	1	2	73
Sep-97	17	100	8	12	112
Mar-99	9	111	2	14	80
Jan-00	11	127	4	11	85
Dec-00	17	137	6	25	81
Feb-02	15	227	4	23	69
Feb-03	9	212	2	10	76
Jan-04	16	204	4	18	85
Jan-05	16	222	7	19	106
Jan-06	24	219	12	45	100
Feb-07	22	218	6	31	84
Feb-08	15	200	5	34	80
Jan-09	28	229	8	31	82
Mar-11	20	215	8	21	88
Feb-12	26	221	9	24	86
Jan-14	25	248	9	29	94
Mar-15	20	234	7	17	81
Apr-17	22	215	10	24	94
Jan-18	25	293	10	40	96
Jan-19	20	206	6	30	87
Feb-20	27	397	7	26	81
Sept-21	24	266	8	35	87

#Note different subsampling methods have been used over the record to estimate abundance.

[28] NPSFM 2020: Where macroinvertebrates are selected as a target value attribute by Regional Councils, the National Bottom Line for MCI is 90, and for QMCI is 4.5.

Table 26: *Results of biological indices from recent in-river biological monitoring of the Ohinemuri River in the vicinity of OceanaGold Waihi (Data from Golder 2015-2017, and Ryder 2018-2021). Categories for MCI are: <80 = poor; 80-99 = Fair; 100-119 = Good; >119 = Excellent (Stark 1985).*

	MCI	QMCI
Nov 2014	Fair	Poor
March 2015	Poor-Fair	Poor-Fair
Nov 2015	Poor-Fair	Poor
May 2016	Poor-Fair	Poor
Nov 2016	Poor-Fair	Poor-Fair
May 2017	Poor-Fair	Poor-Fair
Nov 2017	Fair	Poor
March 2018	Poor-Fair	Poor-Fair
Dec 2018	Poor-Fair	Poor-Fair
March 2019	Poor-Fair	Poor-Fair
Dec 2019	Poor-Fair	Poor-Fair
March 2020	Poor-Fair	Poor-Fair
Dec 2020	Poor-Fair	Poor-Fair
March 2021	Poor-Fair	Poor-Fair

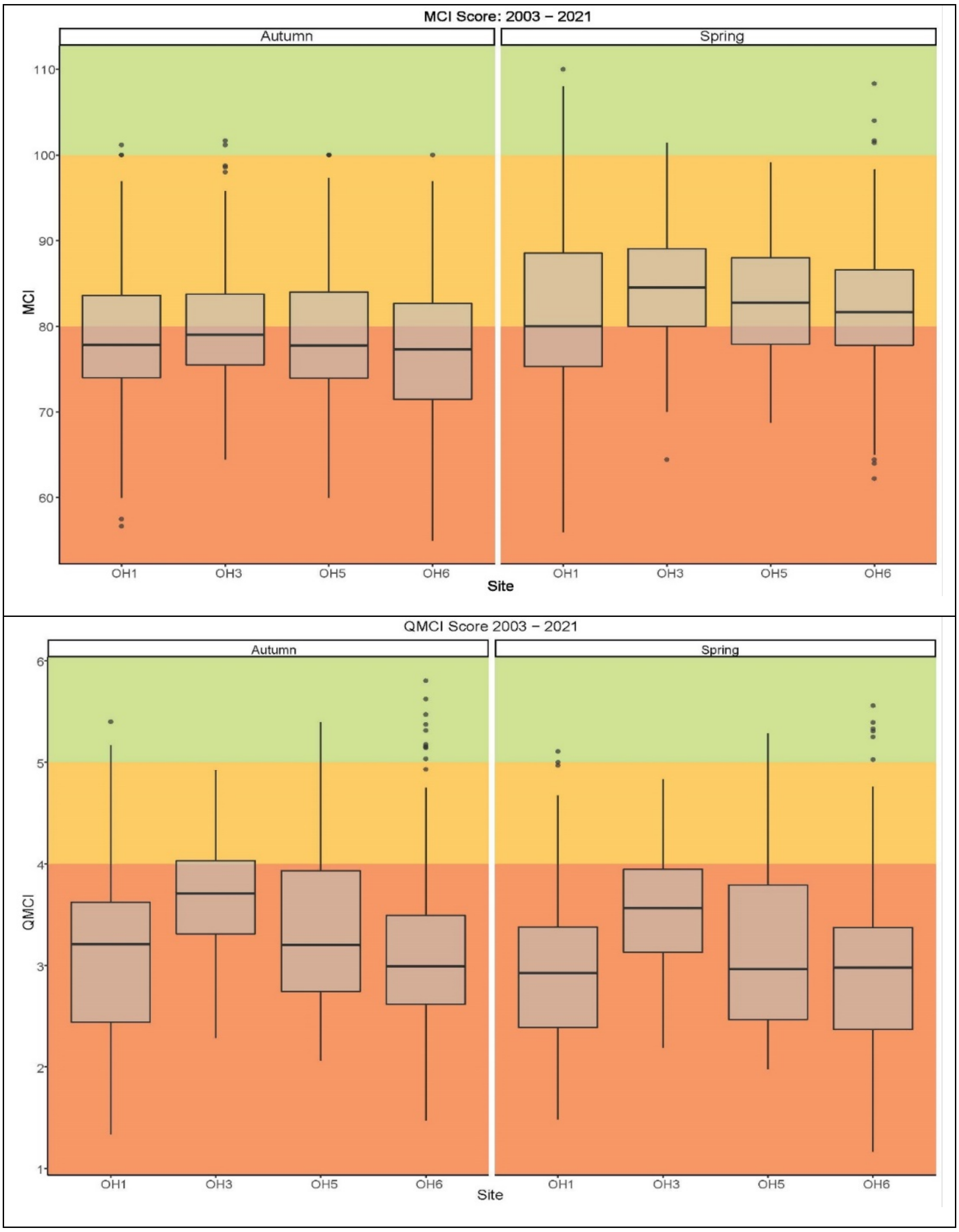


Figure 15: *Boxplots of macroinvertebrate metrics (MCI, QMCI) for sites on the Ohinemuri River, 2009-2017. Data from OGNZL biomonitoring programme. MCI score interpretation: <80 = Poor (red), 80-90 = Fair (yellow), 100-119 = Good (green). QMCI score interpretation: <4 = Poor (red), 4-5 = Fair (yellow), 5-6 = Good (green). See Appendix 7 for interpretation of boxplots.*

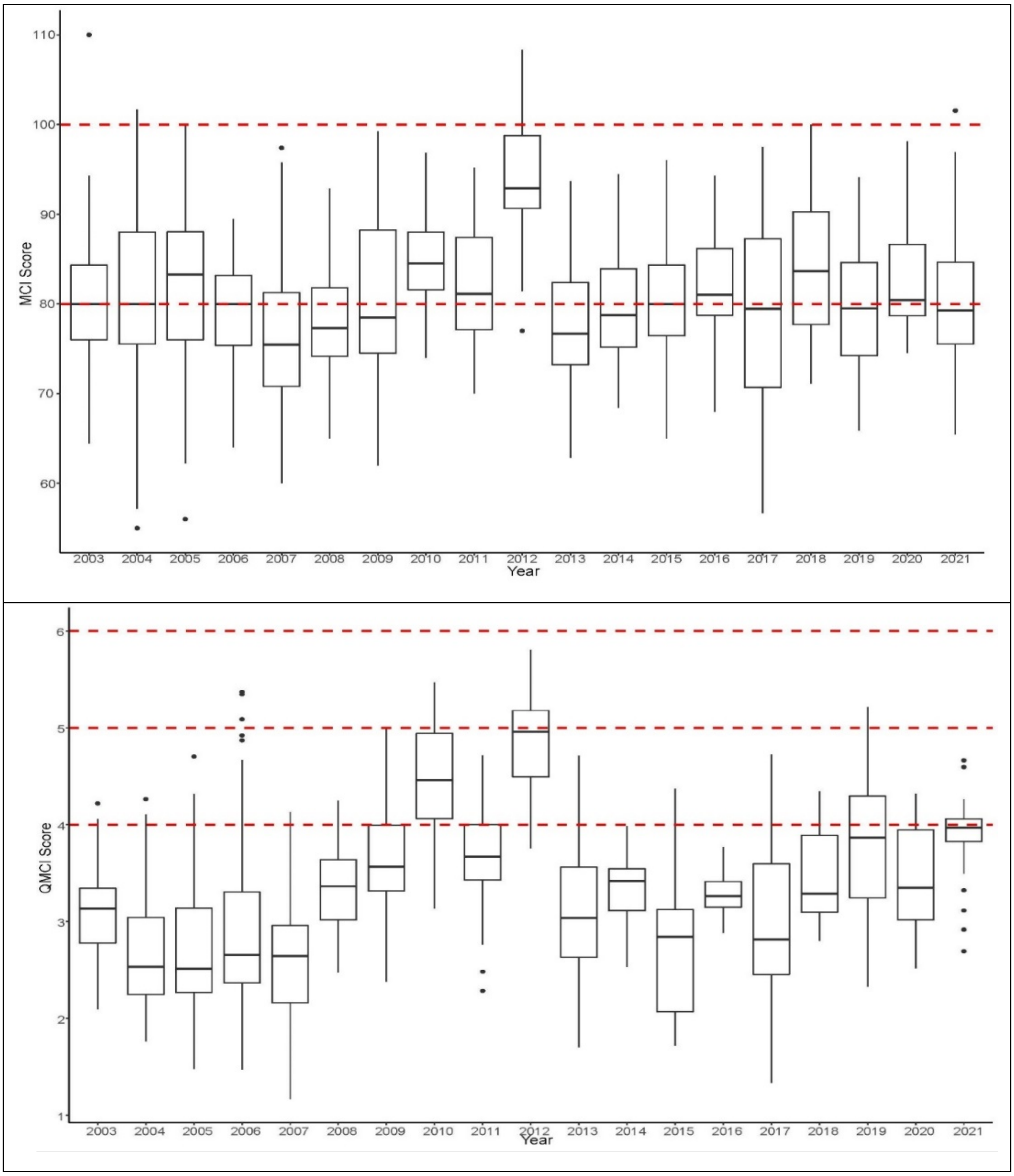


Figure 16: *Boxplots of macroinvertebrate metrics* ***a)*** *MCI* ***b)*** *QMCI for all sites combined for each sampling year (2003-2021). Data from OGNZL biomonitoring programme. MCI score interpretation: <80 = Poor, 80-90 = Fair, 100-119 = Good. QMCI score interpretation: <4 = Poor, 4-5 = Fair, 5-6 = Good. See Appendix 7 for interpretation of boxplots.*

Macroinvertebrate communities – year summaries of OGNZL monitoring

Ordinations of the macroinvertebrate communities from the OGNZL monitoring 2009-2021, are shown in Figure 17. The ordinations reveal patterns in the overall data. The smaller the cluster for each site, means a higher degree of similarity (that is, the communities of macroinvertebrates over the years have not changed greatly). The broader the spread of each site cluster the more dissimilarity is exhibited within the site data.

More importantly, the position of each site cluster relative to the others reveals how similar, or different, the patterns of macroinvertebrate community have been over the 2009-2021 period (Figures 17a,b). The closer each cluster is to each other, the more similar the macroinvertebrate communities, and the further apart they indicate how different or dissimilar they are. For the most part, the clusters of macroinvertebrate communities, are actually on top of each other, in a somewhat 'layered pancake' pattern. This indicates a very high degree of similarity between the sites, both in autumn and spring. In part, this is expected, given the sample sites occur over a relatively short stretch of river with generally consistent habitat conditions. More importantly, it shows that the macroinvertebrate communities at sites downstream of the treated wastewater discharge are very similar to the macroinvertebrate communities above the discharge (or put another way, do not deviate from the control standard upstream of the discharges).

This pattern is better reflected in Figures 17c,d, where each site is represented by year (for spring and autumn respectively). Regardless of their year position on the ordination, each year is tightly clustered together. This shows that the macroinvertebrate communities upstream and downstream sites did not deviate greatly from each other within the season and year of sampling.

Above all it shows that the ecological values as assessed by macroinvertebrates have essentially remained consistent throughout the monitoring period.

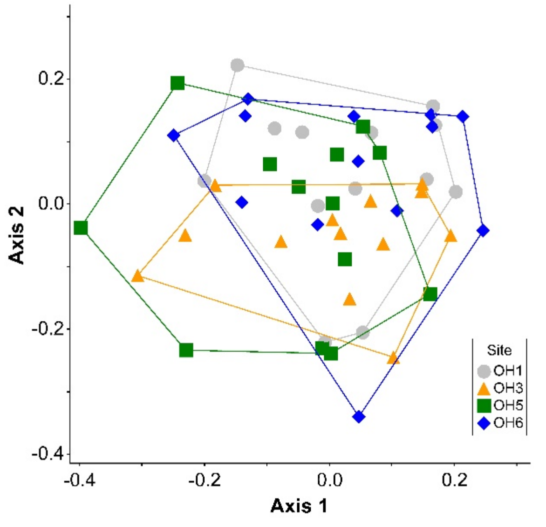
Macroinvertebrate communities – year to year trajectories of OGNZL monitoring

It is instructive to observe whether and how the macroinvertebrate communities between sites and over the years of monitoring by OGNZL have changed relative to each other. Figure 18 shows the year-to-year trajectory for each site from 2009-2021. We acknowledge that the year changes are difficult to discern in these figures but essentially the pattern of movement on the ordination is the same for each sample site.

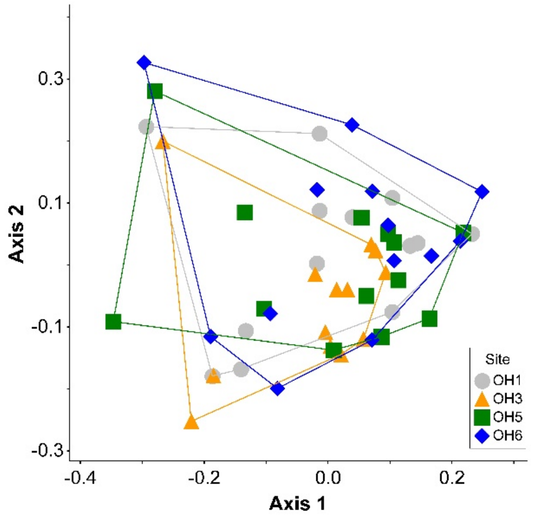
The pattern is better observed in Figure 19, which shows the mean of all four sample locations (OH3, OH5, OH1 and OH6) on the same trajectory. Observing the pattern starting from 2009 for spring, the macroinvertebrate communities of all sites shifted from a central position out to the right of the ordination before circling down and over to the left. The indicator species suggest the recent move to the left in the ordination is a result of grazing and predator feeding macroinvertebrate taxa.

Although located differently in the ordination, the year-by-year pattern is broadly similar for the autumn means, commencing at a location before circling around to a together cluster in more recent years (2019-2021). The pattern as expressed by the indicator taxa is more towards grazing and detritus feeding taxa.

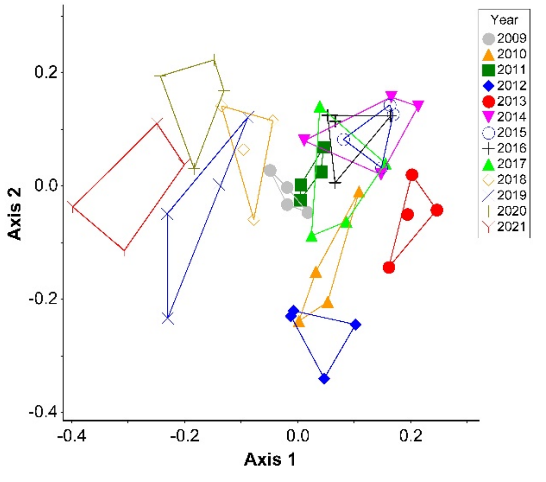
Above all it shows that the ecological values as assessed by macroinvertebrates have essentially remained the same and have moved in similar patterns above and below the discharge throughout the monitoring period.



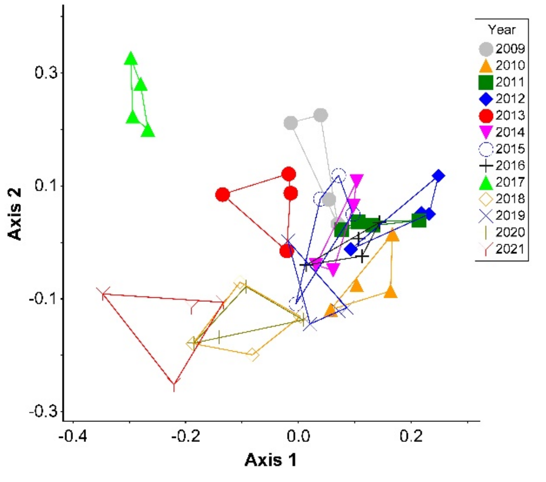
a) Spring: Macroinvertebrate communities logged by site.



b) Autumn: Macroinvertebrate communities logged by site.



c) Spring: Macroinvertebrate communities logged by year.



d) Autumn: Macroinvertebrate communities logged by year.

Figure 17: *Ordinations of spring and autumn macroinvertebrate communities for sites (sites OH1, OH3, OH5, OH6) on the Ohinemuri River, 2009-2021. Data from OGNZL biomonitoring programme.*

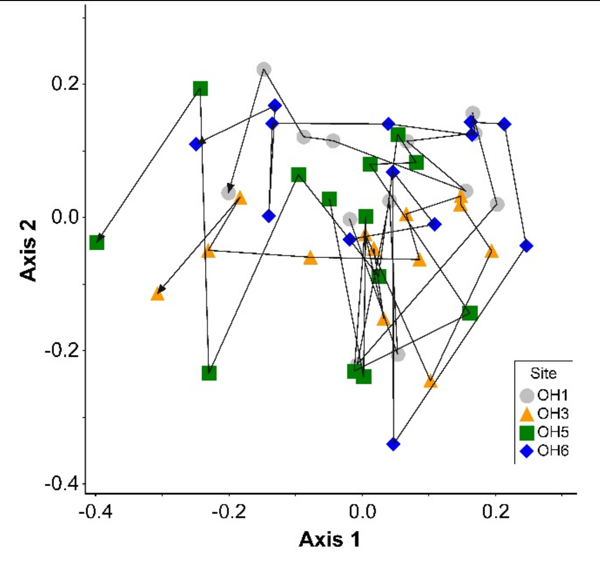
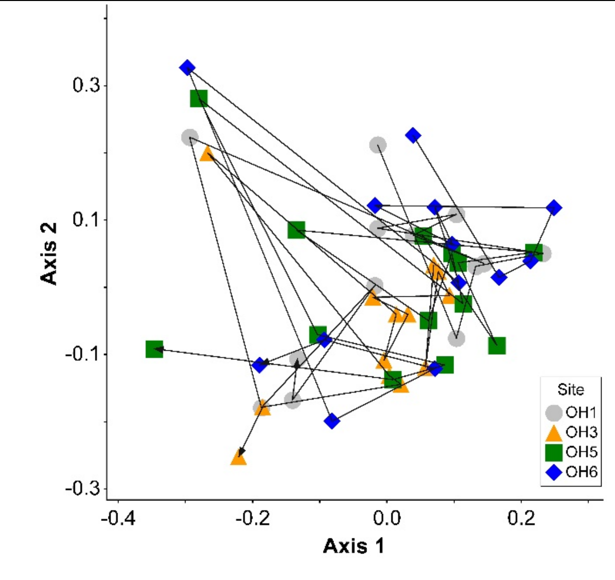
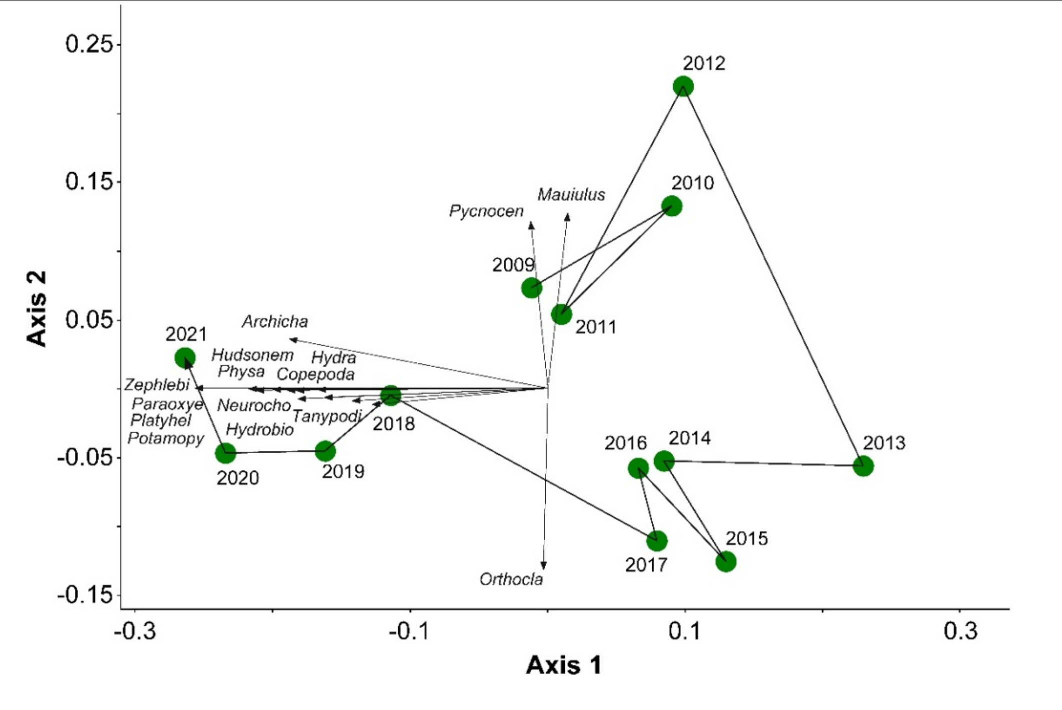
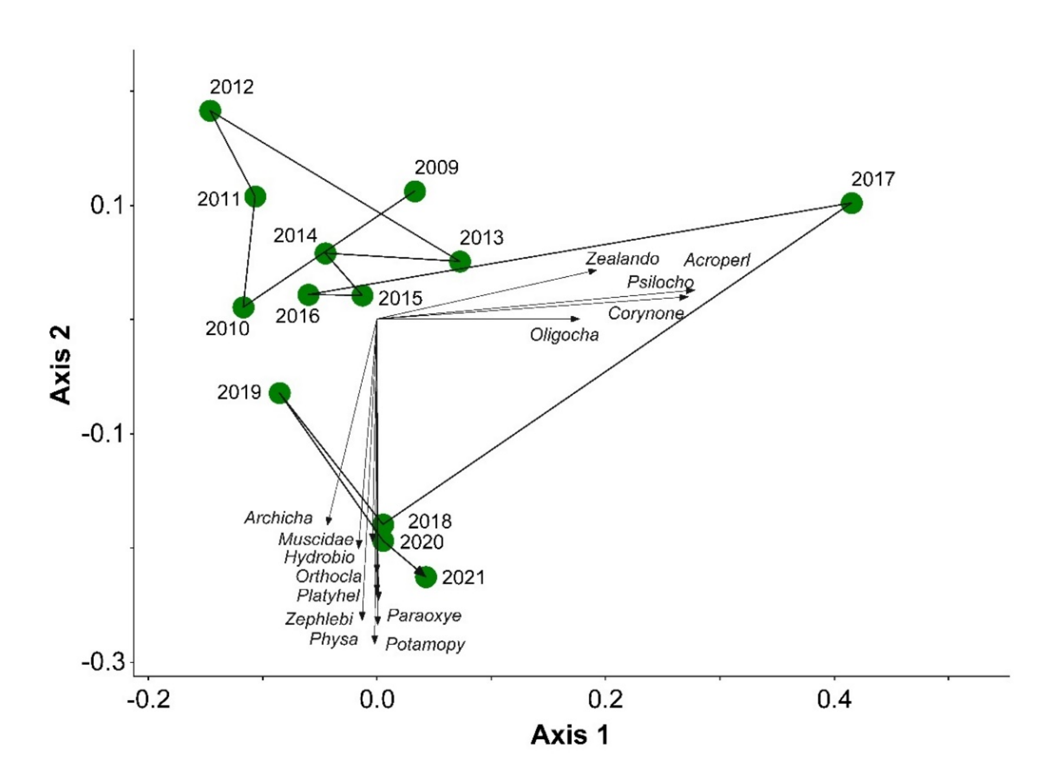
	
a) Spring: Macroinvertebrate community year trajectories – all sites and years.	b) Autumn: Macroinvertebrate community year trajectories – all sites and years.

Figure 18:*Ordination of year-to-year trajectories of macroinvertebrate communities for sites (sites OH1, OH3, OH5, OH6) on the Ohinemuri River, 2009-2021. Data from OGNZL biomonitoring programme.*



a) Spring: Mean macroinvertebrate community year trajectory with indicator taxa.



b) Autumn: Mean macroinvertebrate community year trajectory with indicator taxa.

Figure 19: *Ordination of mean year-to-year trajectories for sites (sites OH1, OH3, OH5, OH6) on the Ohinemuri River, 2009-2021. Data from OGNZL biomonitoring programme.*

NOF macroinvertebrate action plan attribute limits

The NOF sets out limits for macroinvertebrates for ecosystem health (aquatic life) for freshwaters in New Zealand. These limits relate to MCI, QMCI (and ASPM[29]) metrics and are set out in attribute bands for condition of water quality for ecosystem health. The limits for each attribute band are set out to reflect organic pollution/nutrient enrichment. The NOF attribute bands are set out in Appendix 12.

For the most part, the MCI levels within the Ohinemuri River were in Attribute band C or below the NBL in Attribute D.

In summary, the condition of the Ohinemuri River, as measured by macroinvertebrate indicators, is poor to fair. This condition occurs throughout the reach of the river in the vicinity of the OGNZL operations (both upstream and downstream) and has essentially remained consistent over the period of monitoring of the treated wastewater discharge (2009-2021).

13.1.18 Periphyton

Periphyton productivity

Periphyton is also sampled as part of the OGNZL treated water discharge monitoring. As for other biological parameters the results can be variable but ranges from dominance of diatoms to filamentous algae.

Summaries of the Chlorophyll-*a* (chl-*a*) for each of four monitoring sites (OH3, OH5, OH1 and OH6) for the period 2008-2021 are provided Figure . The results highlight the absence of high variability between the sites upstream-downstream over the monitoring period (Figure : $F_{3, 568} = 1.47$, $p = 0.22$). Chl-*a* concentration appears to show minimal variability from 2008 – 2017; however, 2018 to 2021 results indicate an increase in chl-*a* concentrations (Kruskal-Wallis: H(13) = 231.95, $p < 0.001$), exceeding guidelines for the protection of benthic biodiversity (50 mg/m^2, Biggs 2000). Mean (±SE) spring data had higher chl-*a* concentrations compared to autumn (71.4 ± 8.3 and 38.8 ± 3.4 mg/ m^2, respectively). This is more notable in 2021 where algal standing crop or biomass exceed the guidelines for the degradation of higher communities such as trout (= 200 mg/m^2 chlorophyll-a – see guideline in Biggs 2000; Figure 7b).

Standing biomass

Summaries of the Ash-Free Dry Weight (AFDW) for each of four monitoring sites (OH3, OH5, OH1 and OH6) for the period 2008-2021 are provided in Figure 21. The New Zealand Periphyton Guidelines recommend a maximum AFDW of 35 g/m^2 for the protection of trout habitat and angling. The results highlight the absence of high variability between the sites upstream to downstream over the monitoring period (Figure 21: $F_{3, 568} = 1.42$, $p = 0.24$). Similar to Chl-*a* concentration, AFDW appears to show minimal variability from 2008 – 2017 with an increase from 2018 (Kruskal-Wallis: H(13) = 244.89, p < 0.001), with Spring 2021 exceeding guidelines for the protection of benthic biodiversity (35 g/m^2). On average (±SE) spring has higher AFDW compared to autumn sampling (14.2 ± 1.5 and 7.5 ± 0.6 g/ m^2, respectively). This is more notable in 2021 where algal standing crop or biomass exceed the guidelines for the degradation of higher communities such as trout (35 g/m^2 AFDW; Figure 21b).

[29] APSM = Macroinvertebrate Average Score Per Metric, not applied here.

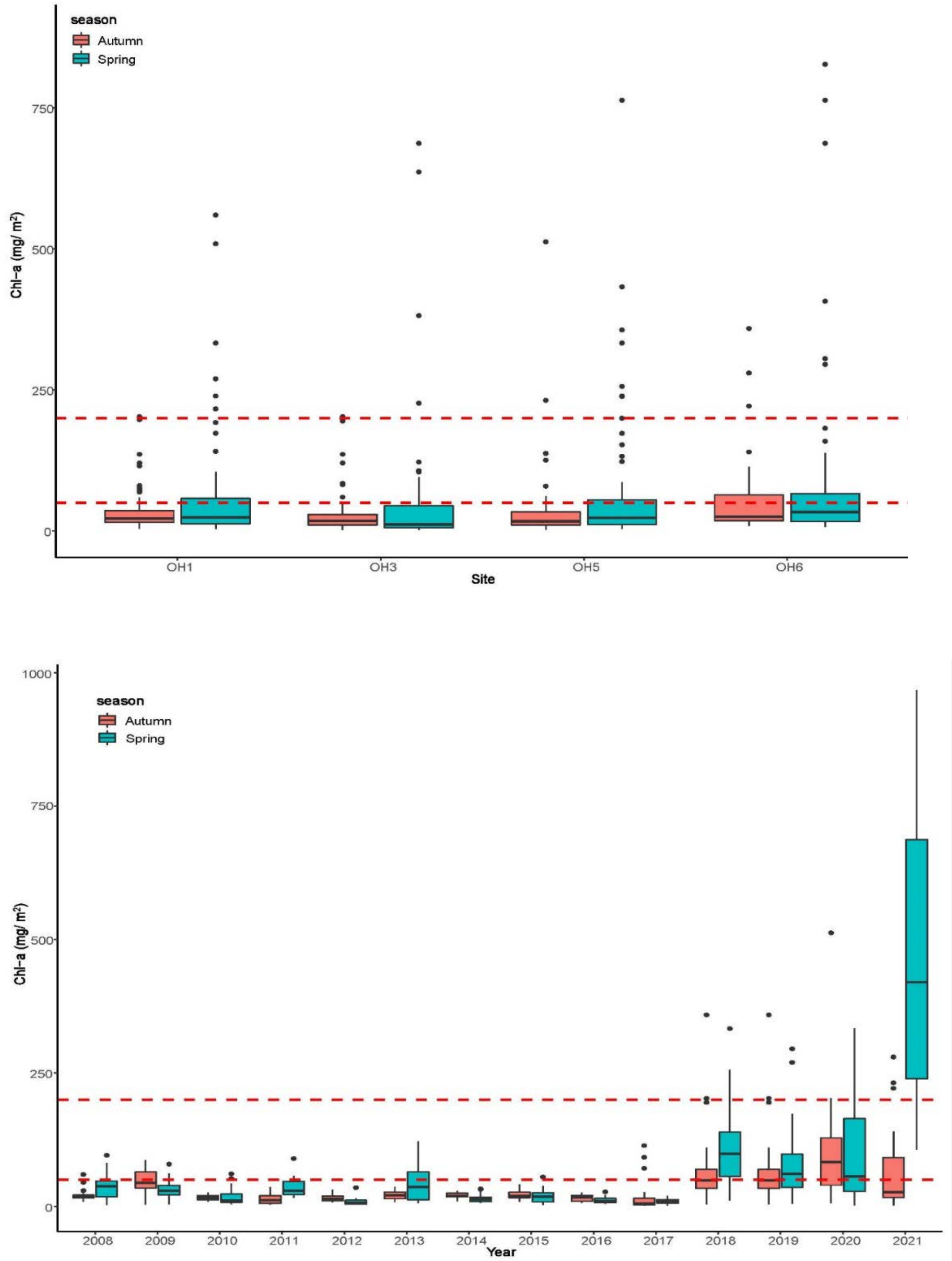


Figure 20: *Boxplots of Chlorophyll a (chl-a) for Autumn and Spring* ***a)*** *for each site on the Ohinemuri River, 2008-2021 and* ***b)*** *for each sampling year. Data from OGNZL biomonitoring programme. The red reference line indicates guidelines for protecting benthic biodiversity (50 mg/m^2 and 200 mg/m^2, Biggs 2000). See Appendix 7 for interpretation of boxplots.*

Periphyton communities

The form of data collection changed after 2017. Therefore, ordinations of the periphyton communities after this date are unavailable but are shown for 2010-2017 (Figure 22). The ordinations reveal patterns in the overall data. As outlined for the macroinvertebrates above, the smaller the cluster for each site (shown in different colours in Figure 22), means a higher degree of similarity (that is, the communities of periphyton over the years have not changed greatly). The broader the spread of each site cluster the more dissimilarity is exhibited within the site data. Greatest variation of periphyton communities over the sampling occurred at Site OH5 during autumn, and OH1 during spring.

However, as for the macroinvertebrate communities, for the most part, the clusters of periphyton communities shown in Figure 22 are on top of each other, in a 'layered pancake' like-pattern. This indicates a very high degree of similarity between the sites, both in autumn and spring. In part, this is expected, given the sample sites occur over a relatively short stretch of river with generally consistent habitat conditions. More importantly, it shows that the periphyton communities at sites downstream of the treated wastewater discharge are very similar to the periphyton communities above the discharge (or put another way, do not deviate from the control site condition).

Above all it shows that the ecological values as assessed by periphyton have remained consistent throughout the monitoring period and since the mine commenced operating in the 1980s.

13.1.19 NOF for Periphyton

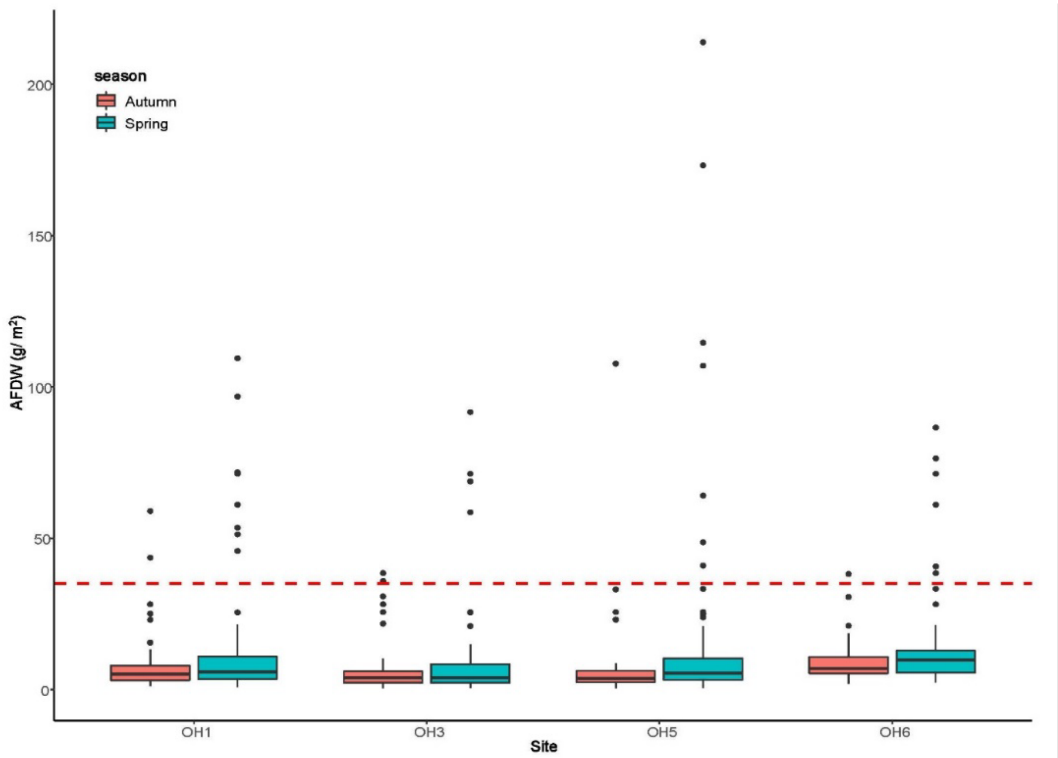
The NOF sets out limits for periphyton for the ecosystem health (aquatic life) objective for freshwater in New Zealand. These limits relate to chlorophyll-a concentrations and are set out in attribute bands for condition of water quality for ecosystem health. The limits for each attribute band are set out to nutrient enrichment and/or alteration to flow regime or habitat. The NOF attribute bands are set out in Appendix 12.

For the most part, the periphyton levels within the Ohinemuri River were above the NBL, although since 2018, median Chl-a levels have gradually increased and in spring 2021 fell below the NBL (>200 mg/m2, Figure 20).

13.1.20 Fish

Shortfin eels and common bullies were the most widespread and common species recorded during monitoring, but longfin eels, Cran's Bully, and rainbow trout were all recorded during monitoring surveys. Banded kokopu have been recorded in earlier surveys.

Several of the 41 species of native fish of New Zealand are 'diadromous' or 'sea run', which means that they migrate between freshwater and saltwater during some part of their life cycle (McDowall 1990). Species such as longfin and shortfin eels, require migration to the sea for breeding; others such as banded kokopu require passage for young larva to the sea for growth purposes. The migration (and spawning) periods are often associated with specific environmental conditions such as rainfall, river flows, temperature, lunar cycles and tidal regimes. Elevated river flows have been considered as a cue for migration upstream. The Ohinemuri River is also an important rainbow trout fishery, with spawning grounds in the river tributaries, and is classified as a significant trout fishery.



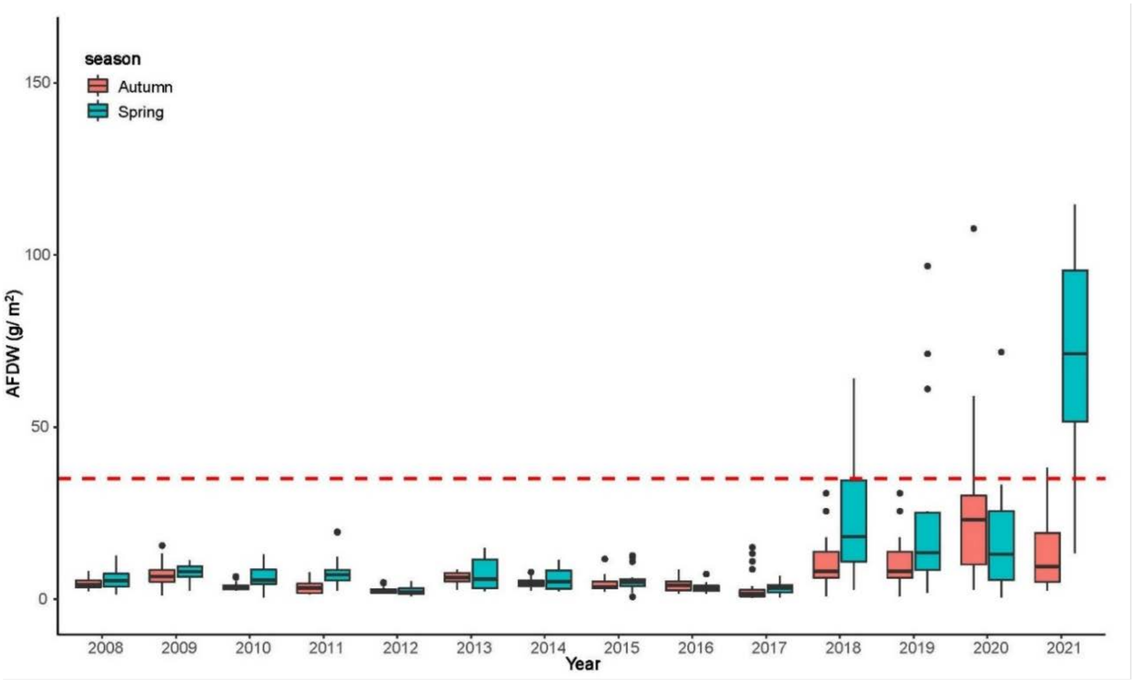


Figure 21: *Boxplots of Ash-Free Dry Weight (AFDW) for Autumn and Spring a) for each site on the Ohinemuri River, 2008-2021 and b) for each sampling year. Data from OGNZL biomonitoring programme. The red reference line indicates guidelines for protecting benthic biodiversity (35 g/m²). See Appendix 7 for interpretation of boxplots.*

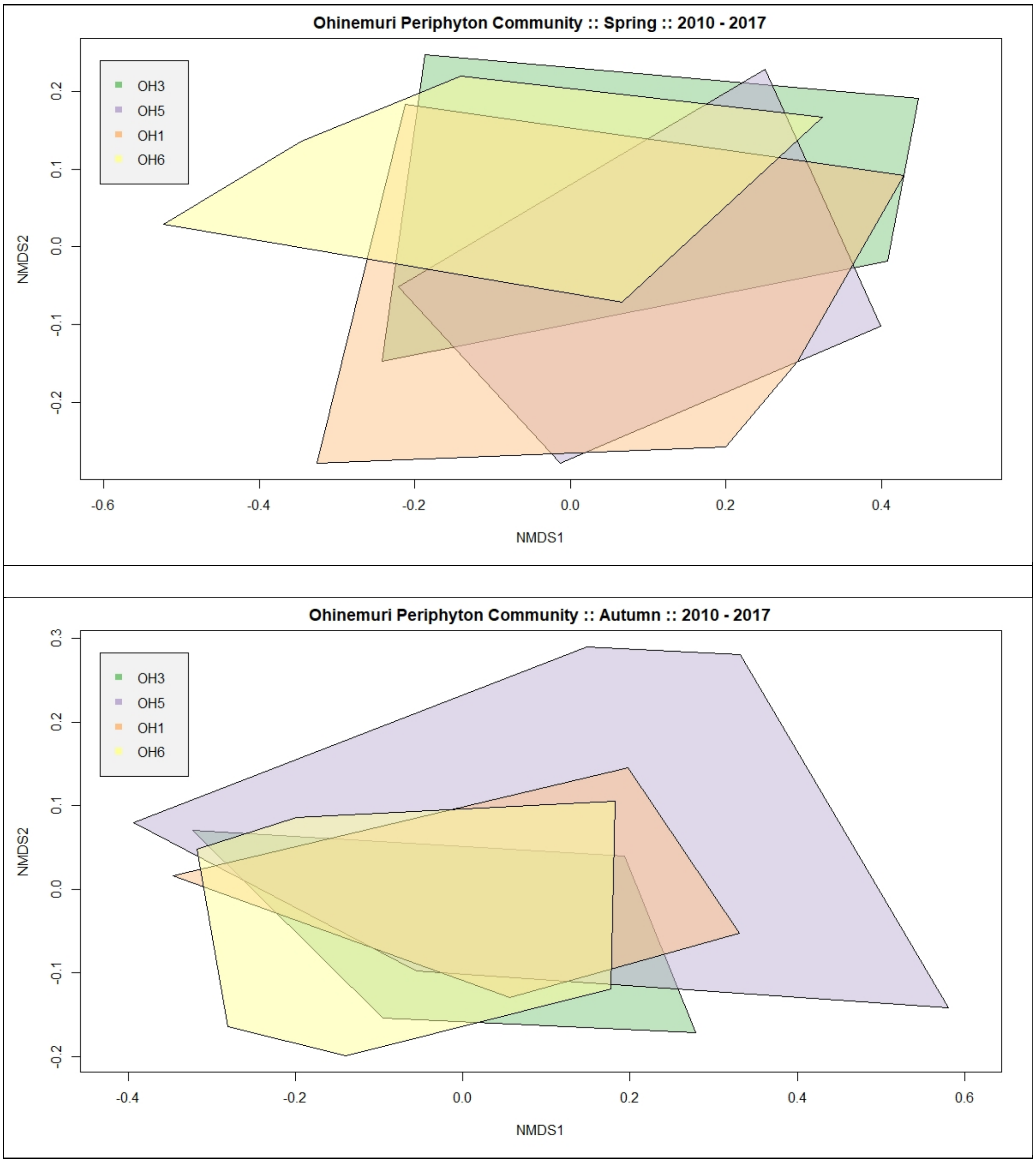


Figure 22: *NMDS ordination of periphyton communities for sites on the Ohinemuri River, 2009-2017. Presence-absence data from OGNZL biomonitoring programme.*

13.1.21 Selenium

As part of the OGNZL monitoring programme required by the treated water discharge consent, selenium is currently monitored in the treated water discharge, river water, river sediments, macrophytes, periphyton and fish. Previously, whole fish body selenium sampling has been conducted in accordance with the methods provided in USEPA (1998). Composite samples of shortfin eels and common bullies from sites upstream and downstream of the WTP discharge points were collected for selenium fish tissue analysis, but currently only tissue from bullies is assessed for selenium.

Selenium levels in both plants and fish have shown to be variable over time and, other than being elevated downstream of the treated water discharge compared with those analysed upstream, without any clear pattern. The selenium concentration in eels collected at OH6 (downstream of the treated water discharge, Figure 14) exceeded the trigger limit of 8.1 mg Se/kg twice over the last ten years of monitoring (March 2018 and February 2017). In addition, the selenium concentration in bullies exceeded the trigger limit twice over the last ten years (June 2018 and September 2008).

Repeat sampling immediately after each trigger limit exceedance revealed no further trigger limit exceedance. Golder (2017) suggested that the lower concentration in the repeat sampling of eels may be from changes in the diet and eating patterns of the fish or movement of eels within the river and its tributaries.

Over a ten-year period, OGNZL has carried out additional monitoring and investigations to determine the cause of the trigger limit exceedances, including a statistical analysis of the data (Golder 2015b) that supported a change to the monitoring programme (a change that is reflected in the results incorporated above).

Update 2021-2025

The analysis of ecological data carried out above is from 2009 to 2021. We have examined the biomonitoring reports of the treated water discharge into the Ohinemuri River for the more recent period 2022 to 2025.

In concluding the most recent annual monitoring of the treated water discharge Babbage (2024) stated that the 'discharge and receiving water monitoring results indicate that OGNZL's mining operations have been undertaken in accordance with consent requirements. Treated water concentrations of the monitored parameters were fully compliant with both normal and maximum compliance limits and OGNZL was fully compliant with the receiving water consent conditions from 1 May 2023 and 30 April 2024. Despite the spatial trends observed for sediment quality, biological monitoring results (periphyton, macrophyte, macroinvertebrates and fish) indicate that the biota remain unaffected between sites and thus, there are no indicators of the systems being under stress'. The same or similar conclusions were reached for the 2022 and 2023 annual monitoring reports (Babbage 2022 and 2023 respectively).

Accordingly, the pattern of ecological attributes within the Ohinemuri River have remained similar above and below the treated water discharge location in recent years (2022-2024) to previous years (i.e., 2009-2021) as detailed above. Therefore, we consider that the conclusions reached from the analysis of the 2009-2021 available monitoring data apply to the present day.

13.1.22 Mercury Bioaccumulation

Background

Current Resource Consent requires that Oceana Gold (NZ) Ltd. undertake specific eel monitoring for the purpose of assessing the effects of the treated water discharge on eel populations and bioaccumulation[30].

[30] The Consent Holder shall undertake eel monitoring upstream and downstream of the treated water discharges and report the results to Waikato Regional Council, [tangata whenua entities to be inserted]. The purpose of the monitoring is to assess the effects of the treated water discharge on eel populations and bioaccumulation. To this end, by 30 June 2010 the consent holder shall submit a

Mercury Limits

The ANZECC (2018) default guideline value for mercury is 0.000012 g/m^3. The maximum compliance limit for the consent is 0.0005 g/m^3 (PQL). The laboratory detection limit is 0.00008 g/m^3.

The annual monitoring of mercury has shown it to be below the laboratory detection levels of 0.00008 g/m^3 and well below the compliance limit. The historical range for mercury within the receiving environment is <0.00008 (i.e., below the laboratory detection limit) to 0.00017 g/m^3 (Ryder 2021). The elevated limit of this range occurred both above and below the treated water discharge.

Eel monitoring

Monitoring of fish, including eels, forms part of the biological monitoring required by the current resource consent. Assessment of fish community, size distribution and density is carried out and reported on annually. The recent annual reports all conclude no significant trends in fish communities, densities or size distribution between sites or season within the ; this includes eels (Babbage 2022-2024).

Ryder (2021) showed that a significant long-term negative trend in shortfin eel densities occurred at sites both above and below the treated water discharge between 2006 and 2021. The strong negative trend above the discharge location means that this trend has not occurred because of the mine operations. Ryder (2021) attributed this trend to other factors such as the past capture and removal of adult eels for selenium testing and potential changes in habitat.

Earlier summaries of shortfin eel densities showed that densities were higher below the discharge than above, and eel health was moderate overall (Golder 2013). The selection and fatalities of eels for the purpose of invasive health checks (blood sampling and tissue assessments) was identified as a detrimental effect on the eel populations and was terminated.

Bioaccumulation

Eel health assessments revealed that mercury has been detected in eels, but levels were significantly higher eels sampled from upstream of the treated water discharge than below (Golder 2013), consistent with water quality results. Variations in mercury levels were attributed to eel size and weight.

The mercury levels in tissue of eels collected from above and below the treated water discharge were similar to levels recorded in eels sampled from the Waikato River, and South Canterbury rivers (Golder 2013). There is no evidence that the treated water discharge is resulting in the bioaccumulation of mercury in the tissue of eels inhabiting the Ohinemuri River, and that mercury levels are similar to those recorded in eels from other rivers in New Zealand.

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monitoring programme to the Waikato Regional Council for its approval and shall undertake the monitoring in accordance with the approved programme.

Summary and recommendations

In summary, some 30 years of annual eel monitoring has shown no changes in eel densities between above and below the treated water discharge and any changes in eel populations are not a consequence of the OGNZL mining operations at Waihi.

Given the above conclusion, and as the mercury trigger limit is lower than the laboratory detection limit (and thus compliance can never be confirmed or denied), there is no evidence of bioaccumulation of mercury (or other contaminants) in the tissue of eels nor the effects on eel populations that have arisen from bioaccumulation.

Accordingly, and to avoid undue stress on eel populations, we recommend that the specific monitoring of eels in the Ohinemuri River ceases. We note that annual fish monitoring in the Ohinemuri River will continue as required by the resource consent, and thus information on eel populations and densities will be recorded.

13.1.23 Riparian Vegetation

As discussed in section 4, it is worth noting that extensive plantings have been undertaken by OGNZL at the OceanaGold Waihi site. In total some 467,500 plants have been planted between 1991 and 2016, for a mix of riparian, swamp, gully and hillside enhancements.

Available records show that of these some 91,600 plants covering 18.8 ha of riverbank were planted along the margins of the Ohinemuri River mainstem in the vicinity of the OceanaGold Waihi site between 1995 and 2005. Given the length of time that has passed since even the last of these plantings, the result is a mature riparian vegetation that contributes significantly to the ecological values of the Ohinemuri River.

In addition to these plantings some 107,000 plants (covering 10 ha) have been planted alongside several tributaries to the Ohinemuri River, including over 70,000 plants (covering 5.9 ha) alongside the Ruahorehore Stream; likewise contributing to the ecological health and values of the river system as a whole.

As the Ohinemuri River in the vicinity of the OceanaGold Waihi is a larger channel (widths range from 6-20 m, Golder 2017), the riparian vegetation does not form a full canopy cover and thus shading across the river is limited. However, we note that the plantings along the Ohinemuri River were for the purpose of bank stability and the reduction of sediment erosion and not specifically for the purpose of providing overarching shade to the river.

13.1.24 Key Conclusions from the Ohinemuri River Monitoring

The key conclusions from the WRC and OGNZL treated water discharge monitoring summarise the current ecological results from the monitoring of the Ohinemuri River:

- There is no evidence of any adverse ecological effects resulting from the treated water discharge on the ecological values of the Ohinemuri River.
- Periphyton (benthic algae) were below the threshold for filamentous algae and algal mats as set out in the NZ Periphyton Guidelines.
- Algal productivity (measured as Chlorophyll a (chl-a) exceeded the NZ Periphyton Guidelines at sites upstream and downstream of the discharges in May 2017; chl-a was highest at the upstream site.

- Periphyton was dominated by diatoms followed by filamentous algae.
- Algal standing crop or biomass was below the thresholds set out in the NZ Periphyton guidelines and in spring 2021 median Chl-a levels were below the NBL for ecosystem health (aquatic life) for periphyton.
- Macroinvertebrate community Index scores (QMCI and MCI) show the Ohinemuri River to range from poor to fair and varies between Attribute C and below the NBL of the NOF for ecosystem health (aquatic life).
- No statistical difference in macroinvertebrate community indices and attributes upstream and downstream of the WTP discharge to the Ohinemuri are evident.
- Shortfin eels and common bullies were the most widespread and common species recorded during monitoring, but longfin eels, Cran's Bully, and rainbow trout were all recorded during monitoring surveys. Banded kokopu have been recorded in earlier surveys.
- Ecological values as assessed by macroinvertebrate communities have essentially remained the same and have moved in similar patterns above and below the discharge throughout the monitoring period.
- The Ohinemuri River is classified as a significant trout fishery.
- Overall ecological values are moderate.

13.1.25 Summary of Ecological Condition of the Ohinemuri River

In summary, in the mid-lower reaches of the Ohinemuri River, indicators of ecological condition suggest moderate ecological values, and values increase towards the headwater areas. There is no evidence that discharges associated with mining activities at Waihi have an adverse impact on the ecological values of the Ohinemuri River, and the benthic periphyton and macroinvertebrate communities have not varied greatly over the period of monitoring. This suggests that the ecological values of the Ohinemuri in the vicinity of the Waihi mining operation have not changed.

It is worth noting, that the Ohinemuri River catchment is not identified as a priority catchment or as an outstanding freshwater body (although the Waihou River at Whites Road is listed to be included as outstanding) in the RPS (section 8.2.1).

13.1.26 Summary of Ecological Values

In this section we summarise each of the WNP elements based on our assessment applying the EIANZ criteria, and our assessment of significance for indigenous biodiversity (based on RPS significance criteria). The overall assessment for each habitat or ecological attribute is summarised in Table 27.

Table 27: *Summary of ecological values and significance for indigenous biodiversity at locations of the WNP.*

Feature	Ecological Value	Biodiversity Significance
Willows Road Farm wetland	Moderate	Y
Gladstone Wetland	Moderate	N
Mataura Stream	High	Y
Mataura Stream Tributaries 1, 2 and 3	Moderate	N
Gladstone unnamed tributary	Low	N
TB1	Low	N
Ruahorehore Stream – upper catchment	High	N
Ruahorehore Stream – lower catchment	Low	N

14.0 Wharekirauponga Underground Mine: Ecological Effects and Management

14.1.1 Proposed Activities

14.1.2 Overview

The proposal at Willows Road involves the development of a single temporary overburden area (referred to as a rock stack) and associated water management features, as well as general site management infrastructure.

The proposed activities relevant to freshwater and wetland ecological values at the location include:

- Development of a single rock stack.
- Borehole(s) to collect natural seepage flows and deliver to the same tributary downstream.
- Creation of a collection pond at the foot of the rock stack to collect contaminated runoff from the stack and send it to the WTP.
- The establishment of a temporary topsoil stockpile.

We have relied on information provided in the following reports:

- WSP 2021. OGL – Mataura Stream Site Visit 21 September 2021. Technical memorandum dated 23 September 2021.

14.1.3 Nomenclature

We note some differing nomenclature of features at the Willow Farm site that occur across the reports listed above and previously published.

- Mataura Stream unnamed tributary 2 (Tributary 2, Boffa Miskell) = northern tributary = catchment R11 (was catchment R1).
- Mataura Stream unnamed tributary 1 (Tributary 1, Boffa Miskell) = southern tributary = catchment R12 (was catchment R2).
- Mataura Stream unnamed tributary 3 remains as tributary 3.

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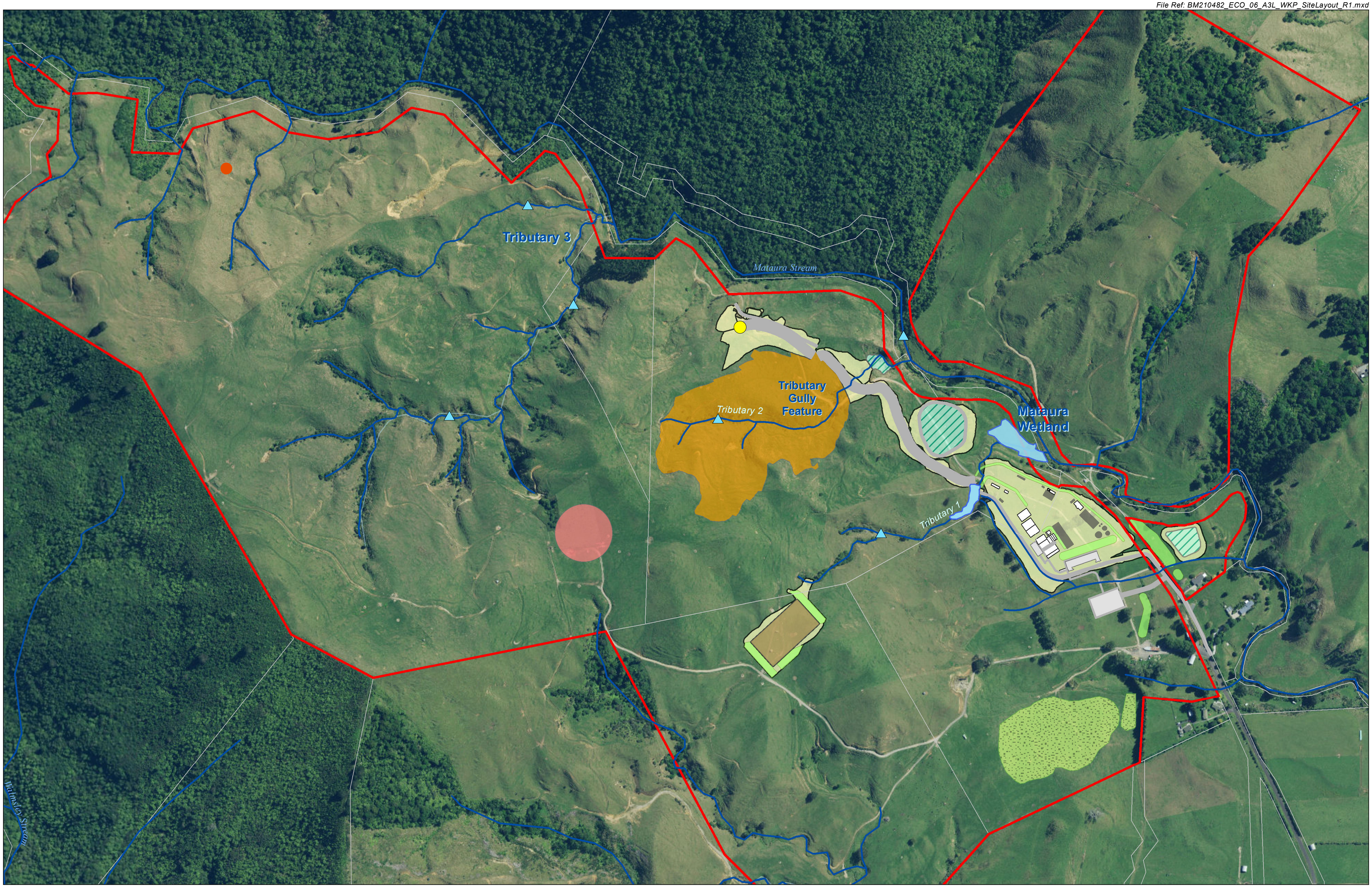

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Data Sources:
Waterways and Roads sourced from LNZ data service
Proposed Infrastructure sourced from Oceana Gold

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Tunnel Portal
- Indicative Shaft
- Freshwater Sampling Site
- Wetland
- Willows Road Site
- Cadastre
- Access Road\Path
- Building Footprint
- Parking
- Bund
- Hard landscape
- Magazine Footprint
- Retention / Collection Ponds
- Willows Rock Stack
- Topsoil Stockpile
- Earthworks
- Helipad envelope (100m)

WAIHI NORTH PROJECT

Proposed Willows Road Site Layout

Date: 26 September 2024 | Revision: 1

Plan prepared for Oceana Gold by Boffa Miskell Limited

Project Manager: katherine.muchna@boffamiskell.co.nz | Drawn: HCo | Checked: KMc

Figure 23

14.1.4 Wharekirauponga Stream catchment

14.1.5 Warm spring

Effects of WNP on the warm spring

We understand that the dewatering of the WUG is likely to cause the permanent loss of the warm water spring. This is because mining activities will very likely intercept the flow of this spring and it will cease to emerge at the surface. This will result in a small reduction in flow to the main stem of the Wharekirauponga (GWS predict Ca. 2.5 L/s).

We have assessed the warm spring feature as low ecological value due to its weak geothermal signature and lack of any unique ecological community. It does not herald a fauna and flora unique to a geothermal ecosystem, but it does have some weak distinguishing characteristics, including a reduced biological diversity. The complete loss of the warm spring feature is a moderate effect (i.e. as per the EIANZ - “Loss or alteration to one or more key elements/features of the existing baseline conditions, such that the post-development character, composition and/or attributes will be partially changed”). This results in a very low magnitude of effect.

The contribution of the geothermal spring to the Wharekirauponga Stream is limited to deposits occurring along the substrate of the true right bank. It does not appear to have a detrimental or modifying effect on the Wharekirauponga Stream and therefore its absence is unlikely to influence downstream ecological values.

The outcome of a low ecological value with a moderate magnitude of effect is a **Very Low** level of ecological effect.

Effects management for the warm spring

As the warm spring appears to be the only warm water spring within the Wharekirauponga Stream catchment, there is no opportunity to look to a similar habitat to protect and enhance to provide additional ecological benefit.

Despite the low ecological value of the warm spring, in that it does not exhibit any unique or distinctive ecological communities, we note that many of the watercourses around the Mataura Stream are fed by natural coldwater springs. For the most part, these coldwater springs are not protected and as for most springs in similar land use environments, are likely to be adversely affected by the current farming practices.

As it is not possible to provide a like-for-like offset the loss of the warm spring, we recommend compensation for the residual effects of the loss of the warm spring. The compensation should focus on the springs and seepages with similar functional and habitat class types (although not with the weak mineral enhanced water attributes) but with better faunal potential and downstream benefit.

We recommend that the compensation for the loss of the warm spring be integrated into the wider package of freshwater mitigation and offset. Accordingly, we recommend that several headwater spring and seepage gullies of tributary 3 (tributary of Mataura Stream) be fenced for stock exclusion and planted with appropriate headwater vegetation. We estimate a ratio-based offset of a 12:1 gain: loss amounting to some 80 m in length of watercourse (approx. 51 m^2 of freshwater habitat) for a loss of some 7 m length of warm spring length (9 m^2 of freshwater habitat) will provide for a no net loss of springs.

14.1.6 Groundwater dewatering effects on freshwater ecological values

Groundwater modelling has identified that the WUG is likely to result in some level of drawdown of groundwater, and that this has potential to affect flows in some of the streams detailed above. This potential occurs within part of the Wharekirauponga Stream catchment and within the broader context of the Coromandel Forest Park. As outlined above, the area within which drawdown may occur is recognised as part of an outstanding natural landscape and includes several streams which are identified as 'natural state waterbodies' and 'outstanding waterbodies' within the Waikato Regional Plan.

A separate and stand-alone report provides an assessment of the effects of the potential dewatering on the surface water streams[31]. Here we summarise the outcomes of that separate report. The focus of the dewatering assessment has been on the potential for the additional reduction in flow on the watercourses when they are already in a natural low flow circumstance.

As we have noted above, the ecological values and ecological integrity of the Wharekirauponga Stream catchment are very high. We also emphasise that the Wharekirauponga Stream catchment, like all watercourses of the Coromandel region, is subject to naturally occurring extreme climatic and weather events and evidence that the ecosystem retains considerable resilience to such climatic extremes is strong and compelling.

When compared with natural low flows, predicted changes in flow are reduced by a very small and marginal amount. We consider that the marginal changes in flow are unlikely to challenge the existing ecological values of the streams of the Wharekirauponga Stream catchment and would be largely undetectable beyond no-change natural low flow circumstances.

Based on the predicted flow statistics, for the most part the streams are unlikely to fail to flow (i.e. go dry at least in the reaches surveyed), result in the loss of populations or communities of instream indigenous biota, or cause pathways for invasive species. At most the proportions of habitat may vary temporarily which may result in temporary changes in biological assemblages. Predicted prolonged reduction in low flow is likely to be minimal and largely undetectable compared to existing low flow circumstances.

Similarly, we do not consider that a scenario where a predicted prolonged reduction in low flow or a periodic occurrence will result in loss of ecological values (communities or species) and effects on ecosystem function are likely to be minimal and largely undetectable compared to existing low flow circumstances.

In summary, the ecology natural state of the mainstem and tributaries of the Wharekirauponga Stream catchment will be retained even if the potential for surface water flow changes eventuates.

[31] Boffa Miskell, 2024. Wharekirauponga Stream Natural State: Effects of potential flow changes on natural state and aquatic ecology.

14.1.7 Waiharakeke Stream catchment

Dewatering of the WUG

GWS have indicated that the temporary loss of flow from the Waiharakeke Stream will be indiscernible, and we conclude that the effects on the ecological values of the Waiharakeke Stream will be negligible.

14.1.8 Mataura Stream Catchment

Effects on Mataura Stream

GHD (2022A) concluded that the effects on the flow in the Mataura Stream resulting from the proposed WRS development at the Willows Farm site are expected to be minimal. The footprint of the proposed rock stack (~5.5 ha) is estimated to be less than 1% of the catchment area and will be removed from the catchment during peak development and runoff will be collected and diverted to the WTP. GHD (2022A) concluded that this is not expected to have a noticeable effect of the Mataura Stream flow.

Effects on Mataura Stream Tributary (Tributary 2)

Loss of stream extent

The proposed infrastructure and rock stack associated with the portal / tunnel on the farmland site has been located to avoid and minimise impacts on the Tributaries as much as possible. However, the rock stack will result in some loss of stream length. The proposed rock stack is sited approximately 200 m upstream from the confluence with Mataura Stream. The placing of the rock stack means that overall, some 558 m of stream (permanent and intermittent) length will be temporarily lost from Tributary 2.

Functional Need

WSP Golder (2022) outline the functional requirements for the rock stack being placed in the tributary 2 catchment:

- Close proximity to the WUG portal.
- Location furthest from the public roads and adjacent properties, with the WRS sited in a natural depression that would lead to least visual amenity and landscape effects.
- The low value of the tributary; the WRS was located above an existing farm access track, in an active grazing area, avoiding the higher ecological value of the lower reach and Mataura Stream.
- Gradient and shape of the natural depression that allows effects to be effectively and efficiently managed.
- Foundation soil conditions and shape of the natural depression that allows for geotechnical stability, a thicker layer of weak clay founding soils in Tributary 1 was a key reason for selecting Tributary 2.
- Size of natural depression was large enough to accept the required rock storage volume.

We understand that a single WRS option was preferred over two facilities to manage volume requirements, mainly due to additional disturbance footprint required for rehabilitation, and to best minimise effects on surface water bodies. The haulage gradient and distance from the portal has a twofold effect on cost first for initial placement and secondly when reclaimed as backfill material for the WUG (WSP Golder 2022).

Loss of ecological values

The ecological values of the Mataura Stream Tributary 2 were assessed as moderate. As outlined above, the rock stack will result in some loss of stream length and therefore a loss of ecological values. Ecological values for Tributary 2 were assessed as moderate.

Water management

WSP Golder (2022) sets out the water management for the WRS with the collection and drainage of clean water underneath the WRS which flows discharging back into the remaining length of the existing Tributary 2 below the WRS.

Tributary 2 rehabilitation

We note that in this circumstance, the loss of Tributary 2 is temporary, but the effects management and stream offset calculations have assumed a permanent loss of this watercourse. Accordingly, an offset is proposed that will meet the potential ecological value assessed through an appropriate ecological offset model to inform a no net loss outcome (refer to section 22 for further detail). We emphasise that the rock stack is expected to have a 10-year lifespan and following that there will be a period of rehabilitation of the tributary.

WSP Golder (2022) set out that once the rock is reclaimed, the WRS footprint topsoil can be replaced, harrowed (where gradients allow machinery) and seeded to return to an end use of grazing pasture. Monitoring and maintenance will be required for a period until deemed a self-sustaining good pasture cover is established. Due to steepness of the natural terrain WSP Golder (2022) recommends that grazing in the first two winters is avoided, and only light weight animals allowed in the other months (weaners or sheep) to prevent soil damage from pugging and soil compaction. A rehabilitated stream channel will be reinstated, and the collection sumps removed. Fencing to exclude stock will be installed and riparian planting undertaken.

The rehabilitation of the tributary (including ensuring fish passage is provided for) will result in an improved and enhanced catchment compared to that at present, i.e. the tributary will also meet its potential ecological value assessed through an appropriate ecological offset model. Combined, the proposed offset and the proposed rehabilitation of Tributary 2 will result in a net gain in freshwater ecological benefit for the Willows Road Farm component of the project.

14.1.9 Effects Management

14.1.9.1.1 General

As outlined above, the NPS-FM requires that the loss of river extent and values is avoided, unless there is a functional need for the activity in that location, and the effects management hierarchy is applied to any effects of that activity (section 3.24, NPS-FM).

14.1.9.1.2 Stream extent

As outlined above some 558 m of stream extent is subject to temporary removal. Thus, although the loss of stream extent is temporary, the loss of extent is offset (as opposed to ecological values) with an equivalent length and area of watercourse. Accordingly, the NPS-FM requirement for *loss of river extent is avoided* is satisfied (NPS-FM, s.3.24).

14.1.9.1.3 Ecological values

As the temporary loss of stream length and associated ecological values cannot be avoided or minimised (for the reasons set out above and in the AEE), an offset is proposed for the residual loss of ecological values (as opposed to stream extent), as per the effects management hierarchy, and the details are set out below and in more detail in Appendix 9.

We have calculated an average Ecological Compensation Ratio (ECR) of 4.5 to the loss of 558 m of ecological values (335 m^2 of stream surface area) providing for just under 1,995 m length (1,863 m^2 of stream surface area) of ecological values enhancement. We have recommended that this offset be applied to Tributary 1 and Tributary 3. Lower catchment flows within Tributary 2 will be maintained from surface water collection and discharge downstream. No enhancement planting will be undertaken on Tributary 2.

14.1.9.1.4 Overview

Prior to any offset occurring, the effects on stream ecological values and extent of the Tributary 2 are **Moderate**.

With the maintenance of flows downstream in Tributary 2, and an appropriate offset for loss of both stream extent and ecological values, we consider that the effects of loss of 558 m of stream length on stream extent and ecological values are **Very Low**. We emphasise that the rehabilitation of Tributary 2 following the removal of the rock stack will result in additional aquatic ecological benefit.

14.1.10 Effects on Mataura Wetland Ecology

Effects

The proposed construction works will avoid the full extent of the Mataura wetland feature. The Mataura wetland containing the swamp maire will be retained and a minimum 10 m planted buffer (with fencing) is proposed around this wetland as part of mitigation (see below).

A desktop assessment of effects on the Mataura Wetland (in terms of hydraulic load) has been carried out by GHD (2022A). Based on the topography of the site (characterised as a steep relatively incised valley), GHD (2022A) inferred that the water source for the wetland is a combination of surface water via runoff and direct rainfall, interflow from infiltrating rainfall within the catchment, and groundwater baseflow.

During mining the catchment supporting the wetland is expected to decrease by up to 19% (as a worst-case scenario)[32]. GHD (2022A) go on to suggest that the water source for the Mataura wetland is therefore estimated to decrease by a similar proportion (and by the same proportion for groundwater recharge).

GHD (2022A) concluded that during wetter winter periods, reduction in recharge is unlikely to result in any impact to the wetland but during drier summer periods, the reduction in peak flows may result in an extended period of lower groundwater levels/dry conditions within the wetland.

[32] This reduction assumes no leakage will occur from the collection pond, which will be dependent on liner design and construction.

They go on to conclude that is not likely to be discernible from natural variability between summer conditions and the effect is at most minor.

14.1.11 Culverts and fish passage

Culverts

Culverts will be installed at stream or overland flow path crossings. BECA (2025) states that culverts will typically be sized to accommodate the 20-yr storm flow. However, key culverts will be sized to the 100-year return event, where build-up of headwater and overland flow would have detrimental effects on infrastructure (e.g., inundation of the SFA, access roads and adjacent property). Erosion protection devices will be installed where required. Typical scour protection and flow energy dissipation devices are discussed in BECA (2025). Culverts will either be concrete pipe or box culverts, subject to detailed design. Piping and culverts relating to the WRS have not been included and are dealt with under the reclamation of Tributary 2.

Fish passage requirements for culverts

Regulations 62 and 63 of the NESF set out the information that is required to be collected and supplied to the WRC. Schedule 9(3) of the Fast Track Approvals Act (2024) also sets out the information requirements in application for complex freshwater fisheries activity approval. That extent of detail is not provided here but the key culverts and their fish passage requirements are provided in Table 28 (from BECA 2025). Fish passage design should follow the guidance provided in the Fish Passage Guidelines (NIWA 2018), noting that these guidelines are for structures up to 4 m in length[33].

Table 28: *Key Culverts at Willows Farm SFA and fish passage requirements. Excludes culverts to be installed at WRS and Mine access road. Culvert information from BECA (2022). Locations of culverts shown in BECA (2022).*

Culvert ID	Design Storm AEP	Approximate Length (m)	Minimum Size (m)	Fish passage requirements
SW-C2A	1%	50	1.5	Passage for climbing fish required.
SW-C3A	1%	27	1.2	Passage for climbing fish required.
SW-C4A	1%	10	1.2	No fish passage requirements. Feature is an ephemeral flow path.
SW-C4B	1%	15	1.2	No fish passage requirements. Feature is an ephemeral flow path.

For completeness we note that although culverts will be placed on the clean water channels of the WRS, no culverts will be placed on the lower tributary 2 and there is no requirement for fish passage during WRS construction and operations. We understand that at rehabilitation of tributary 2 the nine culvert crossings associated with the clean water channels will be removed.

[33] The fish passage guidelines focus on the legislative requirements for providing fish passage and provide the necessary information to allow infrastructure designers to integrate the needs of fish into the design process.

At the time of rehabilitation of tributary 2 any culvert requirements for the haul road will need to be retrofitted to provide passage for climbing fish.

14.1.12 Aquatic Fauna Salvage and Relocation

Effects

Instream works during construction have the potential to cause injury and/ or mortality to native freshwater fauna. Some detail of construction methods is provided within the engineering reports associated with the resource consent application. The construction methods and sequencing are yet to be confirmed, but it is envisioned that any instream works will be constructed in a manner to avoid mortality to native fish.

Effects management

Prior to overburden placement over tributary 2, fish salvage and relocation will occur to avoid the potential for fish mortality. Fish salvage and relocation will be carried out as set out more fully in a recommended Aquatic Fauna Salvage and Relocation Plan.

Instream works will be temporary (for the duration of construction) and potential injury and/or mortality of aquatic fauna will be avoided through relocation efforts. Provided salvage and relocation is conducted, the potential effect (likelihood) of aquatic fauna mortality is very low.

14.1.13 Sediment Discharge to Receiving Environments

Effects

Earthworks over the Willows Road Farm site as well as other proposed activities (i.e. vegetation clearance, drilling, excavation, and stock piling) have the potential to reduce the water quality within Mataura Stream through erosion and sediment runoff and potential contaminants from the rock stack. Excessive fine sediment within a stream has the potential to cover the streambed and smother the natural habitat or fill spaces between the larger substrates. Sediment can also be abrasive and damage the fine structures and gills of the biota.

Some species occurring in the Mataura Stream are particularly sensitive to sediment intrusions, notably those that affix or graze on the hard substrates or capture food from the water column. Amongst those species are the freshwater bioluminescent limpet *Latia neritoides* (suction to hard substrate and grazes on biofilms), blackflies (silk and basal hook adherence to hard substrates; also filter feeds from the water column), net-spinning caddisflies (build cased homes and filter the water column through silk-spun nets), substrate-dwelling mayflies and stoneflies. These modifications can influence the food available to native fish.

Effects management

An erosion and sediment control plan will be prepared as part of the proposed works for the components of the WNP project. Details of erosion and sediment control are outlined Erosion and Sediment Management Plan (OGNZL 2021). Due to the size of the WKP portal infrastructure footprint, a number of sediment ponds are likely to be required to manage sediment laden runoff to protect Mataura Stream from excessive sedimentation.

14.1.14 Water Management

Rock stack runoff will be collected in the collection pond (situated at the base of the rock stack) before being pumped via a dedicated pipeline to the existing OceanaGold WTP.

GHD (2022A) notes that it is assumed that WUG water is piped and pumped through the tunnels directly to the WTP without surfacing at Willows Road Farm during peak development. We also note that the same report assumes that the groundwater inflow is constant and is the dominant water source requiring treatment. The flows presented in GHD (2022A) assume decreasing collection pond water requiring treatment in line with the reduced footprint of the WRS but no reduction in groundwater inflow due to backfilling.

Therefore, no water impacts are expected based on the assumed infrastructure for the WUG. WUG groundwater will be pumped and piped directly to the WTP and collected runoff and seepage from the rock stack will undergo similar transport via storage in the collection pond.

The predicted impact is detailed in GHD (2022) and is conservatively based on the maximum constructed height and extent of the WRS, no groundwater dilution or attenuation.

14.1.15 Summary of Effects Assessment on Freshwater Ecological Values at Willows Farm

The level of effect on freshwater ecological values (including loss of river extent) from the proposed activities range from low to high (Table 29). Our assessment of the magnitude of the different effects assumes that the effects will be subject to the design parameters provided for and the mitigations we have recommended (i.e. design of tributaries, fish passage through culverts, etc). Direct impacts on the Tributary 2 of Mataura Stream will be remedied through conducting fish relocation, and residual effects of 558 m of stream reclamation will be offset through enhancement of 1,995 m of existing stream habitat at Tributary 1 and Tributary 3.

An overview of the ecological values, the magnitudes of the different effects and the assessed level of effect is provided in Table 29. The EIANZ guidance is that low and very low effects should not normally be of concern, but that these effects should still be minimised through appropriate design and management. We provide recommendations to manage effects and implement the proposed designs within the next section.

Table 29: *Overview of the level of adverse effects on the freshwater ecological values at Willow Road Farm.*

Feature	Ecological value	Effect	Magnitude of effect	Level of effect with management
Mataura Stream	High	Earthworks and sediment discharge	Low	Low
	High	Contaminant water management	Low	Low
Tributary 2	Low	Reclamation of 558 m of stream habitat	Moderate	Very low
		Instream works	Low	Very low
		Reduced aquatic connectivity	Low	Very low

14.1.16 Summary of Effects Management

We have assessed each of the effects under the effects management hierarchy as set out in Section 6. Overall, the effects of the WUG at Willows Road Farm can be avoided, minimised, remedied, and any more than minor (i.e.moderate to high) residual effects can be offset (Table 30). By implementing the recommended management measures for each of the potential impacts, the overall level of effect is **Very Low to Low.** .

Table 30: *Application of the effects management and the anticipated at Willows Farm Road.*

Location	Potential Effect	Impact management category	Effects management	Level of effect with management	Anticipated residual effects
Willows Road Farm	Reclamation of 558 m of stream habitat loss (Tributary 2)	Offset plus rehabilitation of habitat loss after removal of rock stack	Enhance nearby stream habitat (offset extent 1,863m) plus rehabilitation of tributary 2 after 10 years.	Very Low	Net gain
Willows Road Farm	Instream works causing loss of native fishes	Remedy plus rehabilitation of habitat loss	Conduct aquatic fauna salvage and relocation.	Very Low	Minimal / None
Willows Road Farm	Earthworks and sediment discharges to Mataura Stream	Minimise	Implement best practice erosion and sediment controls.	Low	Minimal / None

14.1.17 Summary of Recommendations

The potential effects of the proposed activities will be on Tributary 2, and to a lesser extent, on Mataura Stream. The potential effects include the loss and modification of instream habitat and the potential death and/or injury to native fish within Tributary 2 and potential for sediment and other contaminants to enter the Mataura Stream.

These actual and potential adverse effects will be minimised, remedied, and offset as follows:

- The potential for fish mortality will be remedied by the salvage and relocation of aquatic fauna from Tributary 2.
- The potential for sediment to enter the Mataura Stream will be remedied through sediment controls and associated sediment monitoring within the Mataura Stream.

The residual effects of loss of ecological values of Tributary 2 will be offset through enhancing some 1,995m of existing stream habitat in adjacent catchments (tributary 1 and tributary 3).

The effects of the loss of 558 m of Tributary 2 stream extent will be offset through the collective creation of diversion channels within the wider WNP and the additional planting of 644m of stream. Further details are provided below.

Provided all design features, requirements and recommendations are successfully implemented, adverse ecological effects from the proposed development will be minimised, remedied and offset to result in **low or very low levels** of effect with a net gain offset as a result of the rehabilitation of Tributary 2 when the WRS is reclaimed.

15.0 Services Trench: Ecological Effects and Management

15.1.1 Construction method

The Service Trench will be constructed using appropriately sized excavation plant. Excess spoil will be removed off site and shoring methods will be employed if the service trench exceeds a depth of 1.5 m.

Directional boring may be used to install services under SH25 to a yet to be determined invert level. High-density polyethylene services will be continuously welded along the route and placed into the trench on bedding sand and then covered. Detectable tape will be installed above the services prior to backfilling with spoil and compacting. Erosion and sediment control measures will also be employed over the construction footprint and will follow the Erosion and Sediment Control Plan (OGNZL 2021).

15.1.2 Management of the services trench

The services occur as welded sections of high-density polyethylene of high strength and durability. An updated Water Management Plan will detail the operational management and maintenance of the services. We understand that leak detection will be part of the pipe construction design (pressure sensors).

15.1.3 Effects on tributary streams

As set out above, the service corridor crosses two unnamed tributary streams (Sites 4 and 5, Appendix 13) as it approaches the Waihi operations. The services will be contained within a pipeline set out across or under the respective stream or associated with existing bridge infrastructure. The crossings will result in activities within the riparian margin and on the banks of the streams, but no activity will take place within the stream beds. Erosion and sediment management will be applied to the trenching operations and riparian planting is proposed to replace riparian vegetation that is cleared for the operation. Accordingly, effects on the tributaries will be **negligible**.

15.1.4 Extent of watercourses

There is no loss of extent of watercourses because of the construction or operation of the services trench.

15.1.5 Effects on natural inland wetlands

Site 2 Wetland

A single wetland feature was identified at Site 2. WWLA (2023) conclude that the soil profile at Site 2 has already been disturbed to at least the 1.5 m of the proposed trench depth and that given most of the surface water moves in the upper part of the soil profile, any excavation undertaken in dry months will mean the interception of overland flow will be minimal and of short duration. As the lower part of the trench will be in clay any groundwater interception (diversion) during the works will also be minimal. They go on to note that this means there is vertical hydraulic separation, and any trench dewatering will not affect the feature at the lower elevation.

We concur with WWLA (2023) that any effects on the identified wetland feature at Site 2 from excavating the trench through the already disturbed zone will be minimal with respect to the hydrologic and hydrogeological regime and unimpactful of the wetland status and condition. We also emphasise that any construction disturbance will be of a limited period.

WWLA (2023) go on to provide advice on the reinstatement of the feature following construction to ensure that that the same hydrological and hydrogeological regime is reinstated (see below).

Watercourses and riparian vegetation

As riparian vegetation is largely absent at the small watercourse crossings along the route (tributaries a and b), there are no significant effects from the removal or disturbance to riparian vegetation or the aquatic ecology.

Riparian vegetation is limited at the crossing of the Ohinemuri River at Willows Road, but more substantial at the SH25 crossing, and there will be some disturbance to the vegetation during construction. There is a risk that the removal of the vegetation may mobilise sediments in an already highly erodible channel bank, although the quantum is unlikely to result in any significant or detectable impact on the aquatic ecological values of the Ohinemuri River. We consider that the impacts will be minimal but recommend some actions to lessen the risks in the section below.

The proposed methods to develop the services trench (localised, temporary excavation, infilling and revegetation) are not expected to result in drainage or partial drainage of wetland, or any permanent effect on the composition or functions of the feature, and will be managed as required to ensure that does not occur. Erosion and sediment control measures will be implemented for these works and are provided in the Erosion and Sediment Control Assessment Report (Southern Skies 2022).

15.1.6 Effects on Favona Wetland

The service continues and passes close to the Favona Wetland. We have established that the Favona Wetland is a natural wetland under the NPS-FM and therefore subject to the provisions of the NESF. The route of the services trench avoids the wetland but passes within 100 m of the wetland boundary. No earthworks will occur within Favona Wetland, or within 10 m of the wetland. Erosion and sediment controls will ensure that any sediment intrusions into the wetland will be minimised and controlled.

Our understanding of the construction methodology is that the services will be embedded within sand in the trench and then re-covered with the original and same soil material. We do not expect this method to result in any changes to the hydrological conditions surrounding or within the Favona Wetland.

15.1.7 Effects management

Site 2 Wetland

WWLA (2023) provide advice on the reinstatement of the wetland feature following the trench construction such that any disturbance to wetland hydrological and hydrogeological regime remains as prior to the trenching activity. They suggest reinstating the trench with backfill material that replicates the existing soil profile structure. This means a providing a clay medium that underlies a more permeable media (fine gravel) at the surface. The clay backfill should be compacted and can be the full depth of the trench or could overlie a granular media at the bottom of the trench. We have reproduced the post-construction trench rehabilitation concept design in Figure 9 below.

Erosion and sediment controls will be implemented to minimise any discharge of sediments into the wetland feature, and sediment intrusion to the waterways would be notably lessened further if the works were carried out during dry months as suggested above.

Accordingly, we do not consider that the construction or operation of the services trench will result in any partial or complete drainage of the wetland feature at Site 2, and does not result in any taking, use, damming, or diversion of water within, or within a 100 m setback that will result in any impacts to the wetland feature. Therefore, the NESF is satisfied, and no further application of the effects management hierarchy is required.

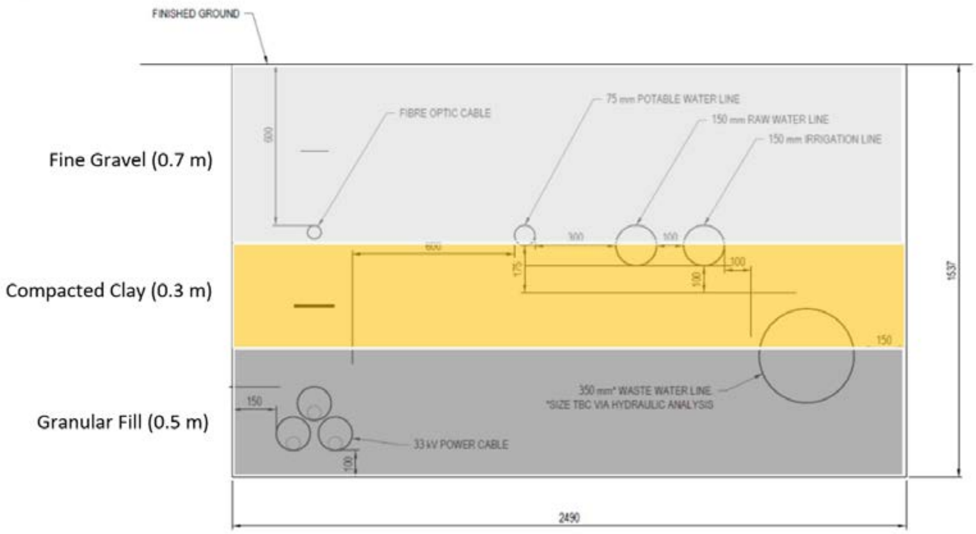


Figure 24*: Conceptual design for reinstating the trench at Site 2 wetland feature. Reproduced from WWLA 2023).*

Watercourses and riparian vegetation

The proposed construction of the trench crosses two unnamed tributaries and crosses the Ohinemuri River at two locations. As noted above the effects on the ecological values of the watercourses and the Ohinemuri River are expected to be minimal, and no further effects management is recommended.

Where disturbance to riparian vegetation occurs, we expect this to have no measurable effect on the freshwater ecological values, but we recommend that disturbance to riparian vegetation is minimised as much as possible, that acceptable erosion and sediment control measures are implemented, and the disturbed riparian areas are replanted and restored.

15.1.8 Summary and Recommendations

The proposed services trench is expected to follow a route that intersects with a single natural inland wetland feature with very low ecological values, and two crossings of the Ohinemuri River (both occurring at existing bridge locations).

The construction of the service trench will not result in the loss of extent or condition of any wetland, nor any (partial or complete) drainage of any wetland. There will be temporary earthworks within the wetland, and appropriate erosions and sediment control measures will be implemented. At this location it is recommended that the trench is backfilled with material that replicates the existing soil profile structure and remedies the disturbance resulting from construction of the trench. Accordingly, effects on the wetland feature are minimal.

The proposed two river crossings occur at existing bridges across the Ohinemuri River. No works are expected to occur within the river bed, but some minimal removal of riparian vegetation may be required, especially at the SH25 road bridge. We recommend appropriate erosion and sediment control measures are established to prevent excessive sediment entering the river, and that any riparian vegetation loss is remedied with appropriate new plantings. Accordingly, effects on the ecological values of the Ohinemuri River are negligible.

In summary, with appropriate reinstatement of disturbed areas of the wetland and riparian areas respectively, the effects of the construction of the services trench on the freshwater ecological values along the trench corridor are minimal.

16.0 Gladstone Open Pit

16.1.1 Proposed Activities

The proposed activities at Gladstone Open Pit (GOP) are:

- Pre-stripping of topsoil from the pit footprint and storage at Southern Stockpile (capacity: 52,500 m^3);
- Relocating the existing Favona portal and associated infrastructure within GOP;
- Installing a new crusher and interconnecting conveyor for transporting rock to the NRS;
- Hauling and storing ore and/or rock at the existing polishing pond stockpile, if required; and
- Construction of noise bunds or screens around the pit rim where required.

The Gladstone Pit will be mined in a period of six years, comprising approximately 2.6 Mt of ore and 18.7 Mt of overburden (waste rock). The overburden generated from the development of the pit is important for the mine material balance, with much of the material being used as construction material for development of a tailing storage facility (TSF) at GOP and for the new TSF3.

Post mining, GOP will be backfilled with waste rock to form a base for converting it into a tailings storage facility. This involves backfilling the pit with 5Mt of suitable rock material and the pit walls will be reworked for this purpose. It is planned that rock will be placed by paddock dumping and then compacted in place by dozing and use of mobile compactor. It is likely that limestone will be mixed with the rock in situ. Once the base layer is formed, the layer will be then covered with a geomembrane liner and tailings from the processing plant will be deposited within the pit. The pit will store 2.1 Mt with a final elevation of tailings at 1103 mRL.

The GOP TSF will operate under the existing TSF operating procedure. It is expected that no more than two TSFs will be in operation at any given time to balance the water treatment rate during operation.

The rate of rise of the tailings in GOP TSF would be upwards of 30 m per year if full tailings stream was directed to this TSF. This would likely give rise to consolidation challenges. It is therefore planned to deposit a smaller fraction of the total tailings stream (i.e. 25% to 50%) to GOP TSF to limit the rate of rise and improve consolidation and reduce post closure settlement.

Once the tailings are filled to the final elevation in the pit, settlement of tailings is expected to continue for the subsequent 10 years. Post settlement, the standing water within the tailings pond will be removed, and a 1 m layer of NAF rock will be placed over the tailings surface for closure. Finally, the area will be rehabilitated. The proposed layout of the GOP is shown in Figure 25.

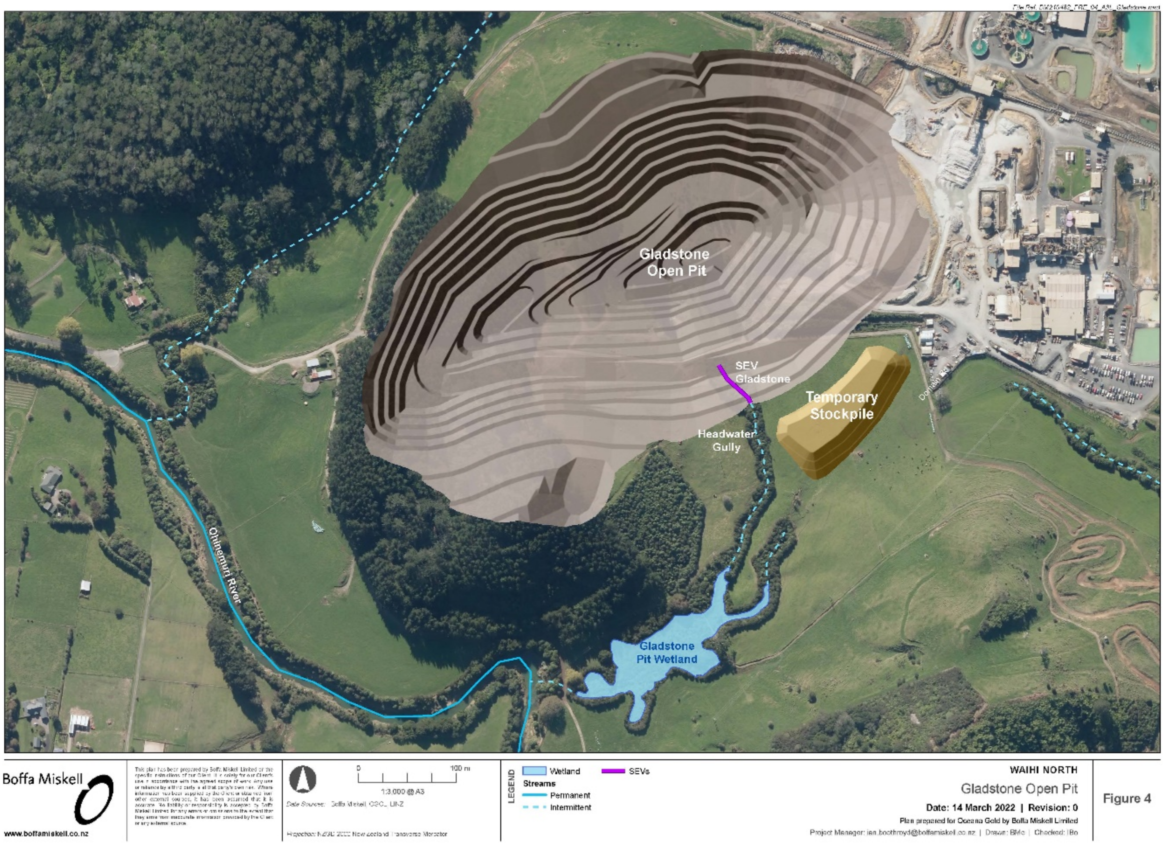


Figure 25: Layout of proposed WNP features and activities at the Gladstone Open Pit.

16.1.2 Effects of construction of GOP on Headwater Gully

16.1.3 Loss of extent of watercourse

Approximately 47 m of intermittent stream channel length (~ 79.4 m^2) of the headwater gully will be reclaimed as part of the GOP. We understand that the loss of extent is unavoidable in forming the pit and extracting the mineral content. A discussion regarding the offsetting of this loss is set out in Section 16.4.

16.1.4 Loss of aquatic ecological values

The loss of 79.4 m^2 of stream extent, including riparian margins, from of the headwater gully results in the loss of habitat and therefore ecological values (assessed as moderate ecological value). This includes the loss of a small area (approximately 47 m length and 0.001 ha) of planted riparian vegetation that will also be removed. The vegetation for removal includes an assortment of manuka and kanuka along with a mix of wet-tolerant plants such as *Carex secta, C. lessoniana*, harakeke and cabbage trees.

We have calculated the ECR of 5.39 for the loss of 47 m of headwater gully, with riparian restoration of a stream reach in the adjacent Ruahorehore Stream catchment.

Calculations for stream offset are provided in Appendices 5 and 9, and summarised (along with our assumptions) in section 22 and Appendix 8.

16.1.5 Effects of construction of GOP on ecological values of Gladstone Wetland

The vegetation removal and earthworks from the headwater gully is greater than 100 m upslope of the Gladstone Wetland and consequently does not trigger any of the provisions of the NESF.

Earlier in our report, it was established that the Gladstone wetland was maintained by groundwater and interflow, and there was no significant hydrological connection between the upper headwater gully and the wetland.

GWS (2021) concluded that after prolonged rainfall, interflow contributions are made from the headwater gully section (Figure 26). Flows from the upper headwaters at Gladstone Hill were in the order of 0.1 L/s and the outflow was 3 L/s. GWS (2022) assess the contribution of flow into the wetland as small, around 3%, and only occurs following rainfall. We understand it is this contribution that would be lost because of the development of the GOP. GWS (2022) go on to conclude that this loss of a small amount of interflow would result in a small loss of surface water flow through the wetland following rainfall and this is expected to be immeasurable.

Similar conclusions were reached in a separate assessment by GHD (2022B) who concluded that the effects of the GOP and subsequent TSF are very similar. GHD (2022B) concluded that the reduction in groundwater discharge by approximately 33% and reduction in groundwater level of approximately 0.5 m adjacent to Gladstone wetland is expected to be unmeasurable given the natural variability within the wetland.

Both GWS (2021) and GHD (2022B) have indicated that a reduction in catchment and groundwater inflow may result in a less frequent saturation of the wetland. We have noted above that the level control at the outlet of the wetland provides for water saturation in the wetland and buffers the wetland against more frequent periods of drying. We expect the wetland to continue to dry during periods of low rainfall.

Accordingly, we conclude that there are unlikely to be any direct or indirect (hydrological) effects on the Gladstone wetland resulting from the loss of 0.14 ha of the upper headwater gully (including the 47m of intermittent headwater gully) and development of the GOP and related TSF.

16.1.6 Effects Management for construction of GOP

The loss of the intermittent headwater gully is unavoidable and therefore there is a residual effect of loss of some 47 m length (approximately 79.4 m^2 of surface area) of intermittent watercourse and associated riparian vegetation. This residual effect of loss of stream area will be offset with stream enhancement (including riparian enhancement). Details of the stream offset is provided in section 22 of our report.

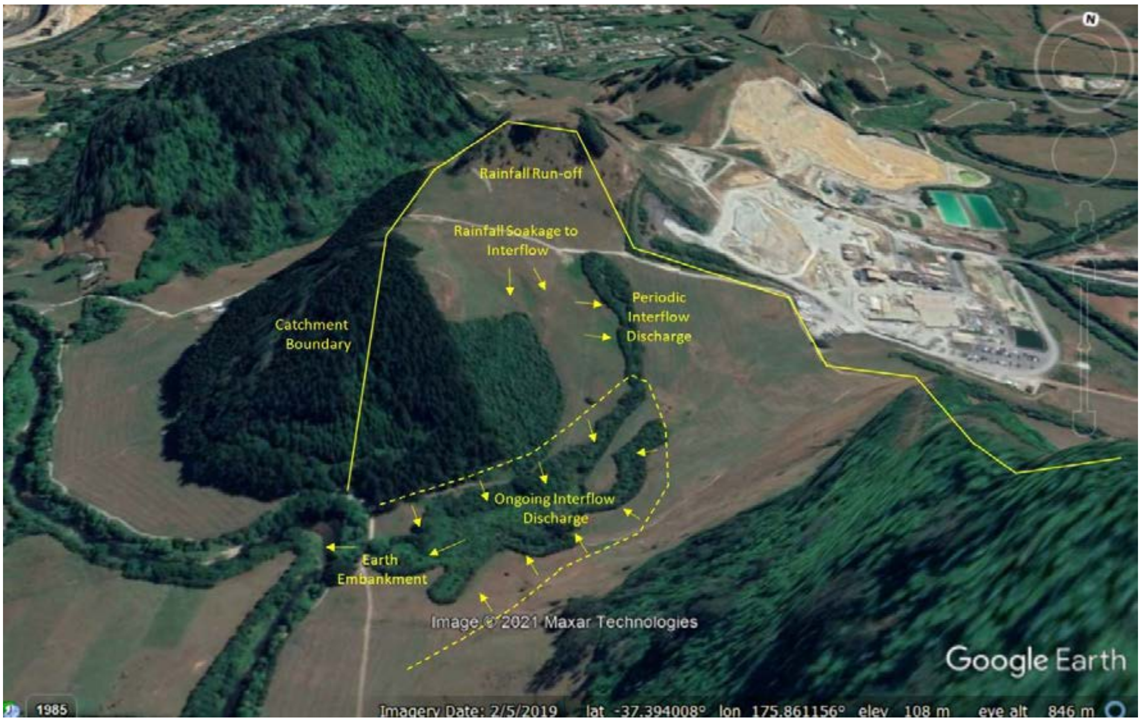


Figure 26: *Conceptual hydrology of Gladstone Wetland (from GWS 2021).*

16.1.7 Effects of potential overflows from GOP TSF on aquatic ecological values

As outlined above, once the base layer is formed within the pit, the layer will be then covered with a geomembrane liner and tailings from the processing plant will be deposited within the pit. Post settlement, the tailings pond will be emptied, and a 1 m layer of NAF rock will be placed over the tailings surface for closure.

GHD (2022A) report that there have been no overflows from the currently active TSFs since the mine has been in operation. Decant water is pumped to the processing plant for re-use or to the WTP. As part of the WTP operation, the storage available in the active TSF is monitored and if necessary, decant water treatment is prioritised to ensure freeboard is maintained. We expect the same management regime to occur at the GOP TSF.

We understand that a surface drain carrying surface runoff waters from the GOP TSF closure landform will discharge via two outlets/spillways, one to the southern side of the GOP TSF in close proximity to the adjacent wetland area, and one to the western GOP watercourse. We expect this discharge to comprise only surface rainwater. We have classified the western GOP watercourse as intermittent, and we would expect the additional runoff to contribute to the intermittent nature of the watercourse, and surface water to the wetland.

16.1.8 Summary of Effects Assessment on Ecological Values

A summary of effects of the development of the GOP is provided in Table 31. The overall level of ecological effect of the proposed activities at Gladstone Pit on the freshwater ecological values is assessed as **Low.**

Table 31: *Overview of the level of effects resulting from the proposed Gladstone Open Pit.*

Feature	Ecological value	Effect	Magnitude of effect	Effects management	Level of effect with management
Extent of watercourse					
Headwater gully	n/a	Loss of 47 m of extent of stream length	High	Offset by creation of equal or greater length of watercourse channel	Low
Ecological values					
Headwater gully	Moderate	Loss of values from 47 m of stream length (~79.4 m^2)	High	Offset with stream enhancement.	Low
		Loss of 0.14 ha of riparian vegetation	Moderate	Offset with riparian enhancement	Low
		Reduced aquatic connectivity	Very Low	Offset with riparian enhancement	Very Low
		Sediment intrusions	Low	Settlement and treatment prior to discharge	Low
Gladstone wetland	Moderate	Sediment intrusions	Negligible	Settlement and treatment prior to discharge	Negligible
		Minimal hydrological variation	Low	Wetland monitoring	Low
Overall	Moderate	Various	Negligible to High		Low

17.0 Effects of Tailings Storage TSF3 on Freshwater Ecology

17.1.1 Proposed Activities

A new Tailings Storage Facility (TSF3) is proposed to provide the tailings storage for the WNP in addition to that provided by the proposed GOP TSF. TSF3 is a downstream earth and rockfill embankment structure, like TSF1A and 2, and forms an impoundment to store the discharged tailings slurry pumped from the Processing Plant.

The layout of TSF3 is shown in Figure 26. This shows the TSF3 embankment constructed between the existing TSF1A embankment and the rising hills to the east which wrap around to the north and behind TSF1A to form the impoundment. The impoundment partially covers the existing East Stockpile area.

The construction and continuing operation of TSF3 will result in the diversion of a tributary of the Ruahorehore Stream. Some 2,118 m will be diverted to form a 2,503 m length of reformed watercourse.

Geotechnical investigations covering the proposed TSF3 site undertaken between 1995 and 2020 indicate the depth to firm bedrock on average is greater than that encountered at the TSF1A and 2 sites and there are also limitations on the practical downstream toe position due to the presence of weak and compressible ground of notable depth (up to 32 m) and extent beyond the site.

To maximise the TSF3 site and provide for a structure of similar geotechnical integrity as the existing TSF1A and 2 embankments, some excavation of areas of weak and compressible soils and backfilling with a structural fill will be undertaken. An undercut to 20 m depth is proposed in an area termed the Paleo Gully, which is the controlling geological feature determining the downstream toe position.

The tailings impoundment is to be fully lined with an earth liner. Additionally, a 1.5 mm HDPE geomembrane liner is proposed within the tailing's impoundment and up to the initial starter embankment height (RL135) to further minimise tailings seepage.

Groundwater beneath the facility will be collected under the base liner of the impoundment and the embankment through a series of subsurface drains. Leachate from the material within the embankment will be collected via a series of leachate drains. Groundwater and leachate collected in the drains will be pumped back to the Water Treatment Plant or the Processing Plant via the perimeter ring main system around TSF1A and 2.

Closure for the TSF3 includes:

- A partial dry capping of the perimeter of the impoundment as has been done at TSF2;
- A wet capping of the tailings in the centre of the impoundment not covered by the dry capping;
- Spill of the uphill diversion drain into the impoundment; and
- Spillway to discharge clean water from the impoundment to the Ruahorehore Stream.

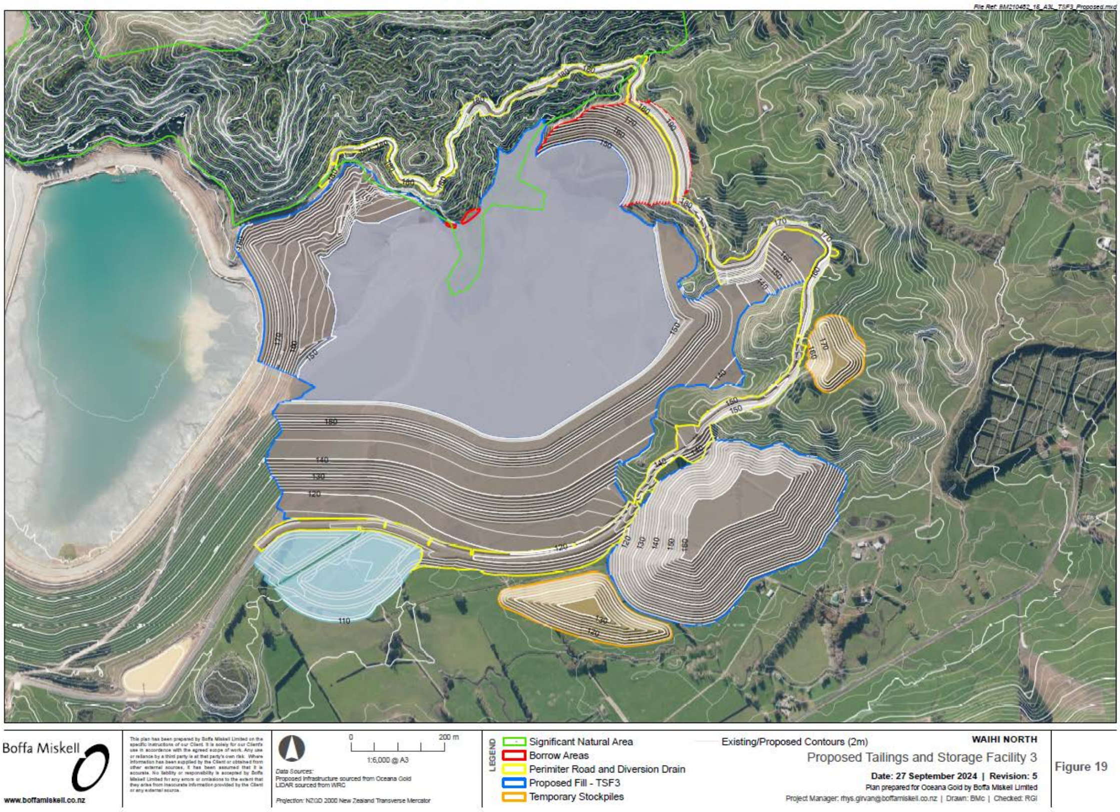


Figure 27:*Layout of proposed WNP features and activities at TSF3.*

17.1.2 Proposed Water and Sediment Management

Clean run-off water from the hills above the TSF will be diverted around the facility to the Ruahorehore Stream. This diversion will be an extension to the existing Southern Uphill Diversion Drain which currently starts behind TSF1A and runs behind the East Stockpile. This drain is set at a level which allows for future potential raising to a crest of RL177. Accordingly, there will be a section of vegetation which will remain between the impoundment level (RL155) and the uphill drain cuts and fills. The length of the new section of Southern Uphill Diversion Drain is approximately 2,950 m.

During construction activities, sediment will be managed using standard erosion and sediment control practices that apply to all earthwork activities. Erosion and sediment management and monitoring is set out in OGNZL (2021) and summarised in section 21 of the current report.

Once PAF is placed, stormwater runoff will be diverted to the lined perimeter drain and collection ponds as is currently done for TSF1A and 2 sites. The ponds are sized to have sufficient capacity to limit discharge over a spillway to Ruahorehore Stream only in high flow events when dilution is effective. In all other situations the water will be pumped back to the WTP before being discharged to the Ohinemuri River or for use in the Processing Plant until the water quality improves sufficiently to allow direct discharge into adjacent waterways.

Collection Pond[34] S5 which provides retention of surface water from the northeast part of TSF1A and East Stockpile will be buried by TSF3 works. This pond will be replaced by a new pond at the intersection of the downstream toe of TSF1A and 3. It will be called Collection Pond S6. Collection Pond S5 currently spills excess water to the TSF1A Perimeter Drain which flows to Collection Pond S4. Collection Pond S4 has a spillway for excess flow to the Ruahorehore Stream. To separate the discharges to allow for more efficient management of surface water as rehabilitation is completed, Collection Pond S6 will have its own spillway to the Ruahorehore Stream, rather than spilling to S4. A new collection pond is required to manage the additional embankment runoff area from TSF3. It will be called Collection Pond S7. Its proposed location is the low-lying area at the toe of theTSF3 embankment which is the natural drainage path for water on the site, and it is immediately adjacent to Collection Pond S6. Collection Pond S6 and S7 will both be fully lined with a 1.5 mm HDPE on a 0.6 m earth liner. A forebay and causeway into the main pond will be features of the ponds that will aid in maintenance, as is used in the existing collection ponds.

A surface water perimeter drain will direct dirty water runoff to the collection ponds. These drains will be HDPE lined. Realignment of 341 m of Ruahorehore Stream is required to make room for Collection Pond S7 and temporary sediment retention ponds.

We emphasise that the drainage channels associated with the water management described in this section do not form any part or contribute to the assessment of recreation of extent of watercourses.

17.1.3 Tailings Storage Management Project Activities

17.1.4 Outline and Footprint

The total footprint of works required for TSF3 is 95 ha. This area includes the stockpile areas, the new embankment and impoundment areas, collection ponds, the uphill diversion drain and area between the impoundment and the uphill diversion drain.

Approximately 8.2 ha (plan area) of the designated Significant Natural Area 166 is included in the overall extent of works. The area between the impoundment and uphill diversion drain does not need to be cleared of vegetation, however, the works for cutting in of the uphill diversion drain is a tight working space and is likely to require cut to fill downslope along the alignment through the SNA. The alignment suggests a conceptual cut and fill extent in the SNA. It is estimated that at least 2.7 ha (plan area) of vegetation will be able to remain between the RL155 impoundment and extent of fill for the extension of the Southern Uphill Diversion Drain. The effects of loss of terrestrial vegetation are reported by Bioresearches (2021).

[34]At the time the collection pond design criteria were devised, in 1996, the potential for low pH and elevated trace elements content in the pond discharge water was a key consideration since there had been instances of pond water quality exhibiting these characteristics in earlier years of operation (1993/94). Changes in management approach to rock handling and placement (which includes lime addition and compaction, as well as advancement in rehabilitation) has resulted in improved surface runoff water quality to the existing collection ponds. It is proposed that for new facilities draining directly to the main branch of the Ohinemuri (i.e. the NRS), that the existing 10 year 72 hour duration storm event is still the appropriate design principal. For facilities draining to tributaries of the Ohinemuri (i.e. TSF3 to the Ruahorehore and the WRS to the Mataura Stream) it is proposed that this design principal be adjusted such that overflow events coincide with high stream flows. From GHD (2022A).

17.1.5 Erosion and Sediment Control

Erosion and sediment control measures will be established before undertaking preparatory works. This will include appropriate silt control to avoid discharge of excessive suspended solids to the Ruahorehore Stream. Similar techniques as utilised for the construction of the other TSFs will be used, including:

- Installation of silt fences on steep slopes where possible.
- Construction of temporary clean and dirty water diversion drains.
- Construction of earth detention bunds.
- Construction of sediment collection ponds.
- Use of flocculants as required.

Details of erosion and sediment control are laid out in OGNZL (2021).

17.1.6 Preparatory Works

Preparatory works will include:

- Clearing site of fences and farm services.
- Relocating power ready for reestablishment.
- Establishing a haul road down East Stockpile to the TSF3 site.
- Sheeting of access roads.
- Progressive mulching and burning (if required) of vegetation.
- Progressive topsoil and vegetation stripping and stockpiling.
- Cutting of additional farm drains as required to drain the surficial soils.
- Construction of the extended Southern Uphill Diversion Drain behind TSF3 site.
- Ruahorehore Stream realignment.

17.1.7 Topsoil Stripping

Topsoil stripping will be required over an area of approximately 80 ha. This includes approximately 5 ha on the existing TSF1A embankment. Stripping of topsoil will be undertaken in stages as required. Vegetation will need to be removed from an estimated area of 5.7 ha in the SNA and 1.3 ha outside the SNA designation. The vegetation will likely be mulched on site and taken to stockpile. Topsoil and vegetation will be stockpiled preferentially in the smaller west and east TSF3 stockpiles. Further information on terrestrial ecology values and effects is reported by Bioresearches (2021).

17.1.8 Cutting of additional farm drains

The preparatory works may result in the development of additional farm drains to expedite the drainage of surficial soils. We have no design of the extent or depth of these drains at the time of writing. The Ruahorehore Stream catchment is already subject to numerous drains and we do not expect the additional drains at the time of the construction of TSF3 to result in changes to the aquatic ecological values of the Ruahorehore Stream.

17.1.9 Extent and Diversion of Waterways

The construction of the TSF3 will result in the diversion (loss of extent) of some 2,118 m of permanent and aquatic habitat within its footprint, including within the SNA. The waterways to be diverted include permanent, intermittent and ephemeral streams, as well as artificial watercourses of the Ruahorehore Stream catchment. A stream diversion of some 2,503 m will be created to convey surface water from the upper Ruahorehore Stream to its lower reaches. The 2,118 m of loss of extent is incorporated within the full diversion length (including the upper reaches of the diversion that are not classified as ecologically functional), and thus meets the requirement of no loss of extent of watercourse.

17.1.10 Ecological values

As outlined above, a section of the Ruahorehore Stream meets the ecological significance criteria and overall, the Ruahorehore Stream is assigned moderate to high ecological values.

We have calculated ECRs for different sections (upper and lower catchment sections) of the Ruahorehore Stream that range from 1.79 to 10.58. Calculations for stream offset are provided in Appendices 5 and 9, and summarised (along with our assumptions) in section 22 and Appendix 8.

The design of the diversion channel is planned to replicate aquatic habitat attributes with a range of suitable stable microhabitats for fish and invertebrates, including the creation of stable pool habitats, the inclusion of gravel and cobble riffle habitats, and provide for the passage of climbing fish, especially eels. Maintaining connectivity between the lower and upper catchment will be important.

All new sections of the diversion channel will be installed off-line and fully stabilised before flows are directed into them. Once the flows are diverted, the existing stream channels will be off-line and can be worked as part of the overall earthworks footprint, with sediment-laden runoff being treated via the main sediment controls (OGNZL 2021).

Indicative designs of diversion channels are detailed in Appendix 11 and are expanded upon in a specific management plan. In addition to the principles, the following recommendations are specific to the Ruahorehore Stream diversion:

- Surface water entering the headwaters of the unnamed tributary to the Ruahorehore stream should be diverted through a diversion channel located to the east of the TSF3 and discharging into the Ruahorehore Stream.
- The diversion channel should convey clean surface water only (i.e. uncontaminated by mining activities) from within the forested catchment above TSF3 and surrounding pasture to the Ruahorehore Stream.
- The stream gradient may make it difficult to maintain (upstream and downstream) fish passage for general fish species, so the design should allow the passage of migrating eels, and other native fish with climbing abilities, allowing them to access the remaining upstream habitat.
- Riparian vegetation should extend to 10 m either side of the channel, where feasible, and must include low-growing species with overhanging cover. It is anticipated that the average riparian width for both sides combined will be 20 m.
- It is anticipated that the gradient and engineering requirements of parts of the upper length of the diversion channel will have a low ecological functionality.

- The lower reaches of the proposed diversion are anticipated to replicate a fully formed ecologically functional watercourse that is connected to the Ruahorehore Stream proper.

17.1.11 Sediment Entering Waterways

The movement of additional sediment from the construction of the TSF3 embankment and haul road could give rise to potential adverse effects on downstream habitats. Sediment can become suspended in stormwater and enter waterways, having the potential for a decline in water quality and the health of downstream aquatic ecosystems. Potential effects include:

- Smothering and infilling of the streambed resulting in a loss of habitat for bottom dwelling organisms including periphyton, leading to the potential loss of food availability for fish.
- Clogging and covering of the gills of invertebrates and fish reducing efficiency of oxygen uptake.
- Modified fish feeding behaviour.
- Cessation of interstitial flow which provides oxygenated water to fish eggs and larval fish.
- Smothering of aquatic plants resulting in loss of habitat for algae and benthic fauna.
- Reduced light penetration and visibility through the water column.

Details of staging and sediment management for the TSF3 construction to avoid and otherwise minimise the above potential adverse effects are set out in OGNZL (2021) and accompanying SSESCP.

17.1.12 Effects of overflow from TSF3 on aquatic ecological values

As outlined above, a spillway will be developed from the TSF3 to the Ruahorehore Stream as shown in Figure 28. As reported above for the GOP TSF, GHD (2022A) report there have been no overflows from the currently active TSFs since the mine has been in operation. As detailed above, the tailings storage ponds are designed with a freeboard allowance that must contain the probable maximum rainfall event with an additional 1 m contingency above the normal operating levels. The minimum crest level for TSF3 is 155 mRL providing a freeboard of 3.17 m GHD (2022A).

Decant water is pumped to the processing plant for re-use or to the WTP. As part of the WTP operation, the storage available in the active TSF is monitored and if necessary, decant water treatment is prioritised to ensure freeboard is maintained. We expect the same management regime to occur at TSF3.

GHD (2022A) predict a low probability of incursion into the required minimum 1 m of freeboard where maximum operating water levels are occurring. These volumes assume Priority One excess flows be directed to the active tailings facility. These excess flows[35] typically occur during low flow periods where the WTP discharge is constrained by the low flows in the Ohinemuri River.

[35] Excess flows are unable to be discharged under the existing consented regimes due to low flow restrictions in the Ohinemuri River which predominantly occur during the summer months. Excess flows have water sources with little buffering capacity within the water management system. These sources include seepage water, processing plant (and WTP) area runoff, collection pond water and groundwater inflows from the WUG, and RS runoff and seepage (via collection ponds). From GHD (2022A).

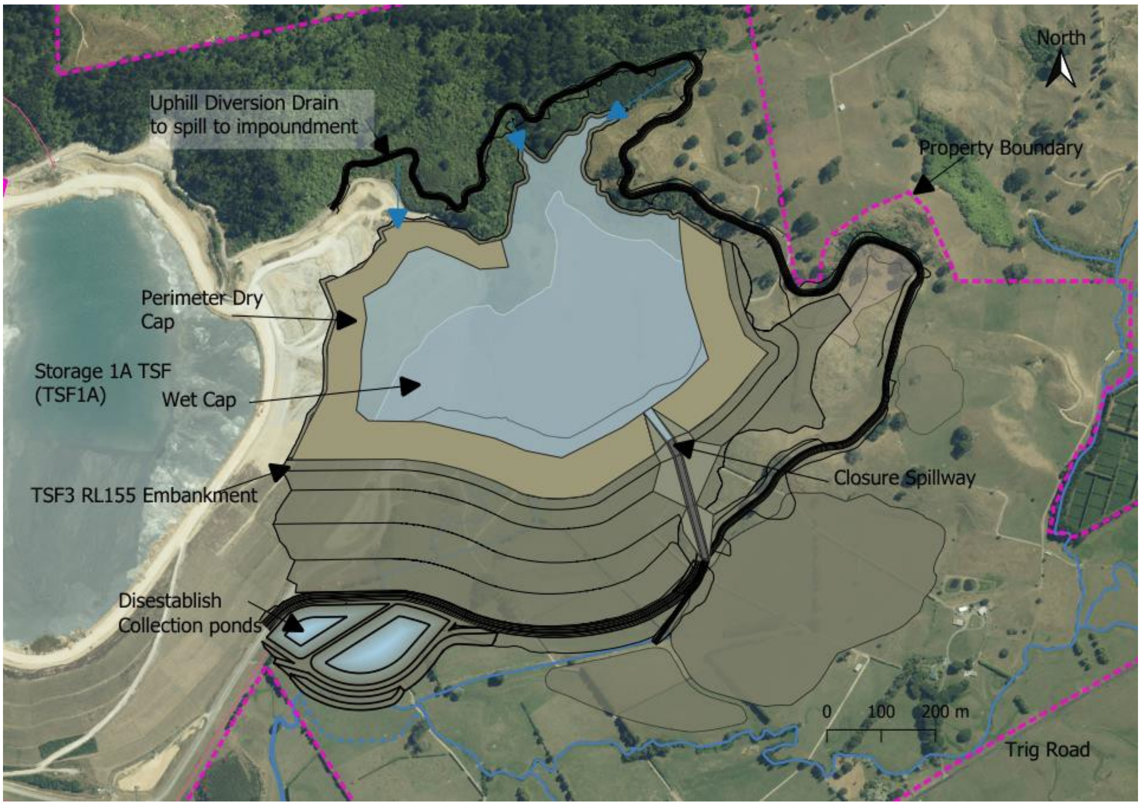


Figure 28: *Layout of TSF3, including location of spillway.*

17.1.13 Summary of Effects Assessment on Ecological Values

A summary of effects of the proposed TSF3 is provided in Table 32

The overall level of ecological effect of the proposed works of the proposed activities at TSF3 on the freshwater ecological values after the application of effects management including offset is **Low**.

Table 32: *Overview of the level of effects resulting from the proposed TSF3 (including effects management).*

Feature	Ecological value	Effect	Magnitude of effect	Effect management	Level of effect with management	Anticipated residual effects
Extent of watercourse						
Ruahorehore Stream	n/a	Loss of 2,118 m of extent of stream length	Low-High	Offset through creation of equal or greater length of watercourse channel (2,503 m length)	Low	None
Ecological values						
Ruahorehore Stream	Moderate - High	Diversion of 2,118 m of stream length	Low	Aquatic fauna salvage and relocation. Enhancement values in stream diversion of 1,800 m length. Stream diversion that is ecologically functional.	Low Low	Minimal / None No net loss
		Reduced aquatic connectivity	Low	Offset through diversion	Low	No net loss
		Sediment intrusion	Low	Settlement management and treatment prior to discharge	Low	Minimal / None
Farm detention pond	Low	Loss of pond habitat	Negligible	Aquatic fauna salvage	Negligible	Minimal / None

18.0 Northern Rock Stack Freshwater Impacts

18.1.1 Proposed Activities

The Northern Rock Stack is planned to contain up to 7 million cubic metres of material and is constructed to a nominal height of RL 173 m. Also proposed are topsoil stockpiles, two of which are constructed at the northern extent of OGNZL owned land and adjacent to Golden Valley Road. The proposed layout is shown in Figure 29.

The diversion drains include a clean water drain which reports directly to the Ohinemuri River and collects clean run-off and stream flows from upstream of the NRS, and a dirty water drain which collects run-off from the NRS and reports to a collection pond. The drains are separated by a 6 m wide perimeter road. The NRS and diversion drains do not encroach into the T13UP166 Significant Natural Area (SNA) scheduled in the District Plan.

The NRS would incorporate similar design features as the existing TSFs to restrict the potential for generation of acid leachate and for leachate to enter surface water or groundwater. These features include a low permeability liner beneath the NRS, subsurface seepage drains to intercept any seepage, leachate collection drains, and capping to minimise oxygen ingress.

18.1.2 Effects on Freshwater Ecological Values

18.1.3 Stream Diversion

An indicative clean water diversion / stream diversion and NRS collection drain will be created as part of the development of the northern rock stack. The diversion drains include a clean water drain which reports directly to the Ohinemuri River and collects clean run-off and stream flows upstream of the NRS, and a dirty water drain which collects run-off from the NRS and reports to a collection pond. The drains are separated by a 6 m wide perimeter road. The NRS and diversion drains do not encroach into the T13UP166 Significant Natural Area (SNA) scheduled in the District Plan.

18.1.4 Groundwater

The NRS will incorporate similar design features as the existing TSFs to restrict the potential for generation of acid leachate and for leachate to enter shallow groundwater. These features include a low permeability earth liner beneath the NRS, subsurface seepage drains to intercept any seepage, leachate collection drains above the liner, and capping to minimise oxygen ingress. A perimeter drain directs surface runoff to a collection pond and a seepage and leachate collection system will comprise manholes, pumps and a pipeline to the existing WTP.

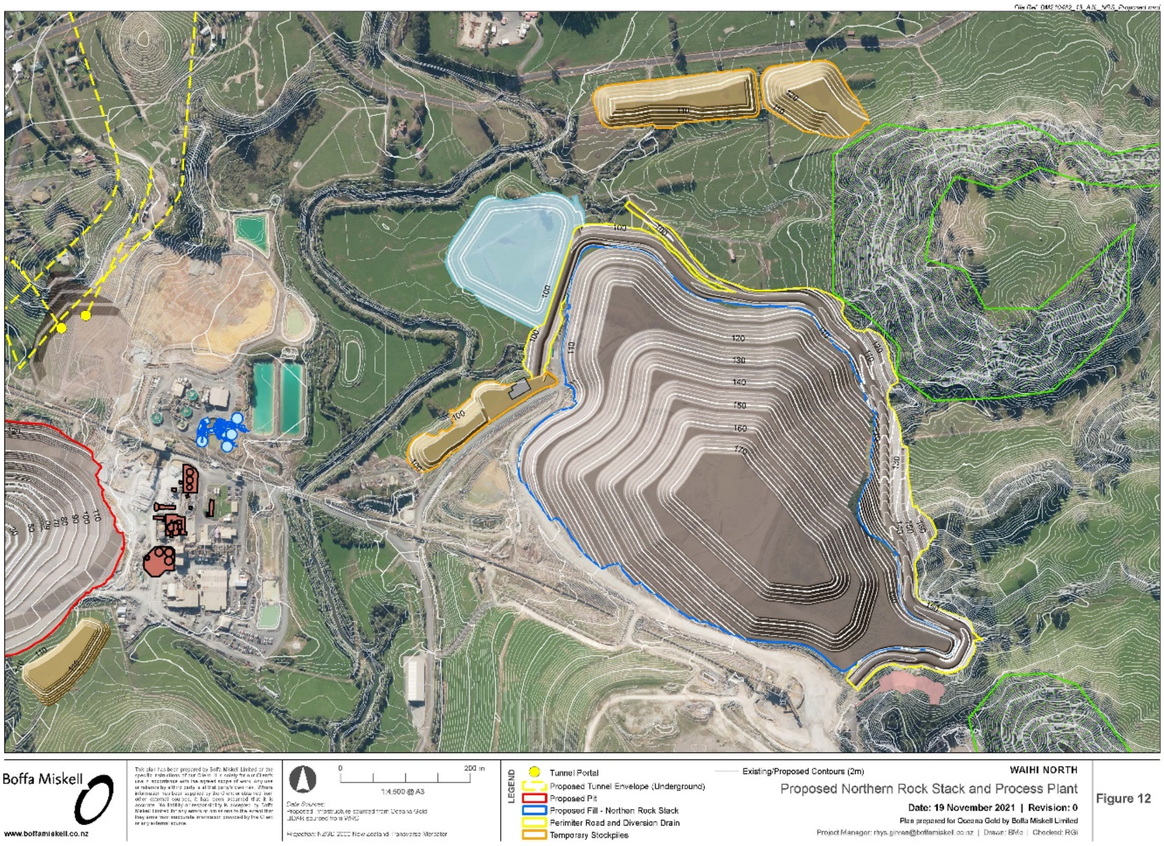


Figure 29*: Layout of proposed WNP features and activities at NRS.*

18.1.5 Erosion and Sediment Control

Erosion and sediment control measures will be established before undertaking preparatory works. This will include appropriate silt control to avoid discharge of excessive suspended solids to the Ohinemuri River. Similar techniques as used for the construction of the TSFs will be used as outlined in section 17.3.2.

18.1.6 Loss and Diversion of Waterways

The formation of the NRS will result in the diversion of watercourse TB1 within the works footprint. The diversion will result in some 1,389 m length (approximately 2,401 m^2 (0.2 ha) of stream area) of permanent and intermittent streams of TB1 to be replaced via a 695 m length diversion and the further collective creation of diversion channels within the wider WNP and the additional planting of 644m of stream. Further details are provided below.

Surface water entering the headwaters of TB1 will be diverted through a diversion channel located between the NRS and the Significant Ecological Area to the north-east of the footprint. The diversion is to convey clean surface water (i.e. uncontaminated by mining activities) from above the site to a new confluence with the lower reaches of TB1.

18.1.7 Ecological values

As outlined above, TB1 has moderate ecological values. We emphasise that TB1 is itself an ecologically enhanced stream diversion.

We have calculated the ECRs for TB1 (and OHE_T4) which range from 1.50 to 5.97 and is provided for by the 695 m of diversion outlined above and riparian planting. Calculations for stream offset are provided in Appendices 5 and 9, and summarised (along with our assumptions) in section 22 and Appendix 8.

The design of the diversion channel is planned to replicate aquatic habitat attributes with a range of suitable stable microhabitats for fish and invertebrates, including the creation of stable pool habitats, the inclusion of gravel and cobble riffle habitats, and provide for the passage of climbing fish, especially eels. Maintaining connectivity between the lower and upper catchment will be important. Riparian vegetation should extend to at least 10 m either side of the channel and should include low-growing species with overhanging cover.

Principles of diversion design are detailed in Appendix 11. In addition to the principles, the following recommendations are specific to the TB1 Stream diversion:

- Surface water entering the headwaters of TB1 will be diverted through a diversion channel located between the NRS and the Significant Ecological Area to the north-east of the footprint. The diversion is to convey clean surface water (i.e. uncontaminated by mining activities) from above the site to a new confluence with either the lower reaches of TB1, or direct with the Ohinemuri River.
- The design of the new channel should meet ecological objectives through the creation of a range of stable microhabitats for fish and invertebrates, including the creation of stable pool habitats and the inclusion of gravel and cobble habitat. The stream gradient may be difficult to maintain fish passage for general fish species, so the design should allow the passage of migrating eels, allowing them to access the remaining upstream habitat.
- Riparian vegetation should extend to at least 10 m either side of the bed and must include low-growing species with overhanging cover.

Additional recommendations for management of effects include:

- The selection and construction of culverts is to be undertaken utilising current best practise to minimise impacts on water quality and in-stream disturbance, and to meet the requirements of the NPS-FM. All work is to be undertaken in accordance WRC's 'Erosion and Sediment Control Guidelines' (WRC 2009) to minimise the impacts of sediment entering the waterway.
- Water flow is to be diverted around the working area by using an open diversion channel or by pumping the water around the work area.
- Fish passage is to be maintained through any culverts installed in permanent or intermittently flowing waterways to allow the migration of eel species.
- All native fish and trout, kōura and freshwater mussel within the working area are to be salvaged and relocated outside the area of works, prior to work starting.

18.1.8 Culverts and fish passage

Culverts

Culverts will be installed at stream or overland flow path crossings. BECA (2022) state that culverts will typically be sized to accommodate the 20-yr storm flow. However, key culverts will be sized to the 100-year return event, where build-up of headwater and overland flow would have detrimental effects on infrastructure. Erosion protection devices will be installed where required. Typical scour protection and flow energy dissipation devices are discussed in BECA (2022). Culverts will either be concrete pipe or box culverts, subject to detailed design.

Fish passage requirements for culverts

Schedule 9(3) of the Fast Track Approvals Act sets out the information required for lodgement for approval, and Regulations 62 and 63 of the NESF set out the information that is required to be collected and supplied to the WRC. That extent of detail is not provided here but the key culverts and their fish passage requirements are provided in Table 33 and located in Figure 30. Fish passage design should follow the guidance provided in the Fish Passage Guidelines (NIWA 2018), noting that these guidelines are for structures up to 4 m in length[36].

Table 33: *Key Culverts at NRS and fish passage requirements. Locations of culverts shown in Figure 29.*

Culvert ID	Design Storm AEP	Approximate Length (m)	Minimum Size (m)	Fish passage requirements
OHE_T8	1%	15-20	1.5	Passage for climbing fish required.
OHE_TX	1%	15-20	1.05	Passage for climbing fish required.

18.1.9 Effects Management for Sediment.

The movement of additional sediment from the construction of the NRS and haul road has the potential to give rise to adverse effects on downstream habitats. We have outlined the effects of sediment in streams above.

All new sections of the diversion channel will be installed off-line and fully stabilised before flows are directed into them. Once the flows are diverted, the existing stream channels will be off-line and can be worked as part of the overall earthworks footprint, with sediment-laden runoff being treated via the main sediment controls (OGNZL 2021).

All work is to be undertaken in accordance with the Erosion and Sediment Control Plan and accompanying SSESCP (OGNZL 2021) to minimise the impacts of sediment entering the waterway. The use of flocculants does have the potential to introduce chemicals to waterways, so consideration must be given to the discharge of water where flocculation is used. The chemical treatment of sediments is outlined in OGNZL (2021) and Chemical Treatment Management Plan (OGNZL 2022).

[36] The fish passage guidelines focus on the legislative requirements for providing fish passage and provide the necessary information to allow infrastructure designers to integrate the needs of fish into the design process.

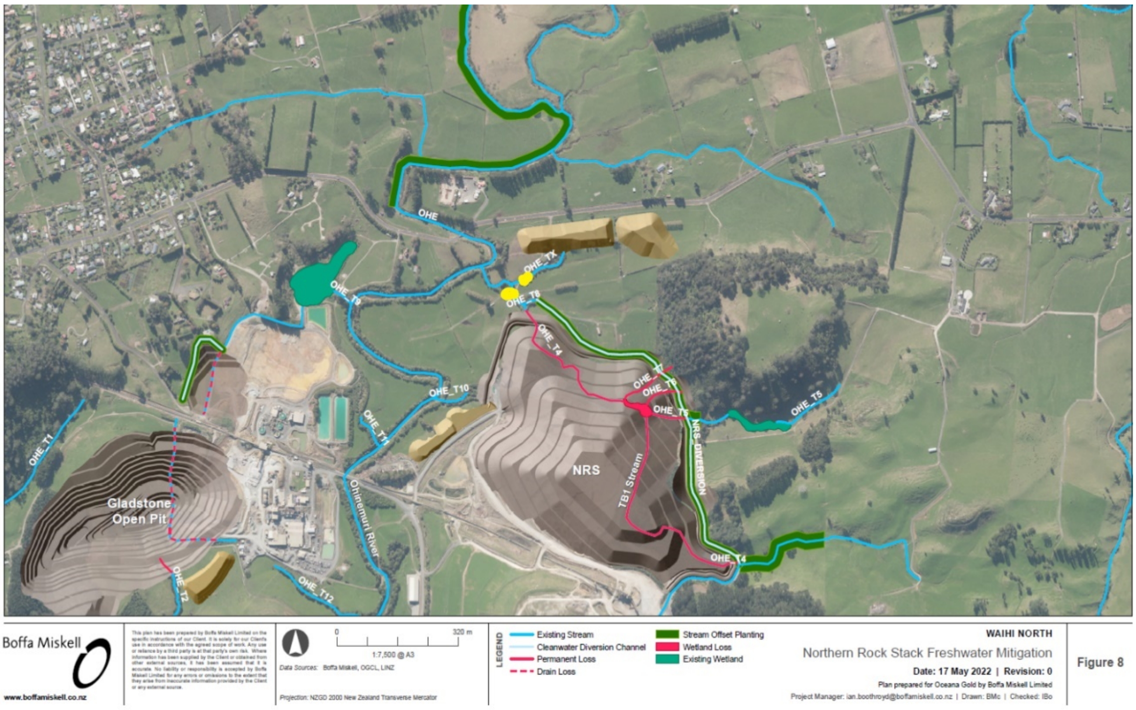


Figure 30:*Location of culvert installations at NRS (culverts indicated by yellow).*

18.1.10 Summary of Effects Assessment on Ecological Values

A summary of effects of the proposed NRS is provided in Table 33. The overall level of ecological effect of the proposed works of the proposed activities at NRS on the freshwater ecological values after application of effects management is **Very Low**.

Table 34: *Overview of the level of effects resulting from the proposed NRS (including effects management).*

Feature	Ecological value	Effect	Magnitude of effect	Effects management	Level of effect after management	Residual effects
Extent of watercourse						
TB1	Moderate	Loss of 1,389 m of length of stream (enhanced diversion)	Moderate	Creation of watercourse channel (695 m length)	Low.	None
Ecological values						
TB1	Moderate	Diversion of 1,388 m length of stream	Low	Aquatic fauna salvage and relocation. Enhancement values in stream diversion of 695 m. Ecologically functioning diversion.	Very low	Minimal / None No net loss No net loss
		Reduced aquatic connectivity	Low	Offset through diversion	Very low	No net loss
		Sediment intrusion	Low	Settlement and treatment prior to discharge	Very low	Minimal / none

19.0 Discharge From the Water Treatment Plant

19.1.1 Introduction

As outlined above, it is proposed to renew the WTP Discharge Consent to allow for a term of consent sufficient to cover the full duration of the Waihi North Project including an appropriate closure period. In this section we assess the water quality and the ecological values of the Ohinemuri River. We demonstrate that as no changes are planned to the nature of contaminants within the discharge to the Ohinemuri then no increased effects will occur on the ecological values of the Ohinemuri River.

Nevertheless, in this section we review the effectiveness of the existing water quality criteria in terms of maintaining the ecological values of the Ohinemuri River.

Our assessment demonstrates that the standards currently imposed on the discharge consent via conditions remain appropriate for the protection of ecological values of the Ohinemuri River. Our assessment also reviews the effects of the discharge against the relevant attribute states expressed in the NPS-FM, noting that as yet the National Objectives Framework has not been applied to the Ohinemuri and so environmental outcomes, target attribute states, and implementation plans have not been established.

We also assess additional parameters of the treated water discharge and the condition of the Ohinemuri River. In particular, given the concerns raised by WRC regarding elevated temperatures within the Ohinemuri River catchment as a whole (WRC 2019, and section 3 above), and our understanding of potential elevated sulphate levels within the treated water discharge, we provide further commentary on the effects of elevated temperature and sulphate within the Ohinemuri River in this section.

19.1.2 Ecological Values

We have outlined the past and present water quality and ecological values of the Ohinemuri River earlier in this report. Most notably, the information available shows that the ecosystem attributes and the ecological values of the Ohinemuri River have not varied throughout the duration of the current treated water discharge to which the USEPA (1986) receiving water criteria have applied and has not been adversely affected by the OGNZL treated water discharge.

Despite the MCI and QMCI biological indices recorded from the annual biological monitoring programme returning generally poor-fair scores for water and habitat quality (both before and after the establishment of the WTP discharge), the ecological metrics for the Ohinemuri River both upstream and downstream of the discharge show fluctuations in ecological values from poor to high values. At-Risk fish have been recorded in the Ohinemuri River, and the river is also an important rainbow trout fishery, with spawning grounds in the river tributaries, and is classified as a significant trout fishery.

19.1.3 Water Management

GHD (2022A) outlined the water management approach for the WNP and describe the water treatment process at the WTP. Mine water, cyanide water and potentially impacted runoff water are treated at the WTP before discharge to the Ohinemuri River at two locations (E1 and E2) via multi-port diffusers (see chapter 20). Treated water is stored in Polishing Ponds prior to discharge where it is tested for compliance with the relevant discharge criteria. The volumes and water quality of the various mine water and cyanide water sources are heavily dependent on a number of environmental and operational variables. The primary controlling variables are rainfall, ore and rock geochemistry, processing rate, dewatering rate, river flow rate, and tailings facility age.

There are currently five consented operating regimes[37]. Each operating regime has a range of discharge quality limits that enable compliance with in-stream water quality criteria. Trace element removal rates are described in GHD (2022A). The WTP discharge regime is shown in Table 35.

Table 35: *WTP discharge volumes, rates and estimated percentage of Ohinemuri River flow under various operating regimes (from GHD 2022A).*

Criteria	Operating Regime A	Operating Regime B	Operating Regime C	Operating Regime D	Operating Regime E
Daily Discharge	20,000 m^3/d	26,000 m^3/d	5,200 m^3/d	26,000 m^3/d	52,000 m^3/d
Discharge Rate	235 l/sec	301 l/sec	60 l/sec	301 l/sec	602 l/sec
Percentage of river flow	15%	20%	10%	40%	60%

19.1.4 Proposed Water Management for WNP

GHD (2022A) concluded that, based on their water balance analysis, the WNP can be implemented using the existing and upgraded WTP functionality and within the current consented discharge and receiving environment conditions. The estimated volume of water from WUG has a significant impact on the total volume of water requiring treatment at OGNZL's Baxter Road facilities, and the capacity of the current WTP facilities will require upgrading throughout the project's lifetime to cope with the expected volume of water requiring treatment.

Due to discharge restrictions during low river flow periods, GHD (2022A) also notes that there will be excess water requiring treatment during summer dry periods once WUG is developed. GHD (2022A) outlines how these flows can be managed and OGNZL is investigating a range of water reuse options that could be implemented to reduce the amount of water ultimately needing to be discharged to the river.

We also note that GHD (2022A) states that the utilisation of the reverse osmosis (RO) plant to further reduce concentrations of elevated trace elements is a contingency that could be utilised in the event that predicted discharge concentrations are higher than predicted.

[37] Resource consent (RC AUTH971318.01.13).

20.0 Water Quality Criteria for the Ohinemuri River

20.1.1 Introduction

Resource consents 971285, 971311, 971312, 971303-971306 and 971323 document the receiving water quality standards that are to be met by the discharge of treated water to the Ohinemuri River. These receiving standards were originally derived from USEPA (1986), the applicable standard at the time these consents were granted. The results outlined below and the lengthy history of monitoring of ecological values within the Ohinemuri River, show that there has been no adverse effect on in river ecological values from the operation's treated water discharge. In fact, throughout the reach of the Ohinemuri River in the vicinity of the OceanaGold Waihi operations, the ecological characteristics of the river have remained consistent over the period of monitoring.

Our assessment compares the merits of retaining the existing USEPA (1986) standards as detailed above, against the application of more contemporary standards. This will assist in determining whether the presently permitted receiving water quality standards remain appropriate and effective at properly mitigating the ecological effects of the discharge.

20.1.2 Ecological Values

A fundamental question in the application of water quality standards is what ecological values are to be protected or safeguarded. In section 13 we outlined the past and present water quality and ecological values of the Ohinemuri River.

The information available shows that the ecosystem attributes and the ecological values of the Ohinemuri River have not varied since the application of the USEPA (1986) receiving water criteria.

20.1.3 Comparison of Values

We have provided a comparison of the receiving water quality standards set in the existing resource consents with the ANZG (2018) guidelines, at various levels of ecosystem protection (Appendix 10). For the purposes of the application, we have applied the 95% level of ecosystem protection, despite the ecological values varying in condition, and indicators suggest that the condition of the Ohinemuri River is in fact poor-fair.

It will be apparent that the existing receiving water standards are, for most parameters, higher than the ANZG DGVs. This is to be expected as the DGVs act as 'trigger' levels, requiring further investigation if exceedances occur, as compared to actual standards derived specifically for the biotic communities of the Ohinemuri River. A number of DGV trigger levels (selenium, mercury, lead) are higher than those provided for by the resource consents.

We also note that, for most of the parameters (as associated with the receiving water quality standards) there is no change in the DGVs from the trigger levels provided by the ANZECC (2000) guidelines.

20.1.4 Water Quality of the Ohinemuri River

Water quality of the Ohinemuri River at each sampling site for the period 2008-2021 is provided in Figures 30 and 31, and on each is plotted the resource consent standard, and the ANZG (2018) trigger DGV. These graphs clarify how the water quality of the Ohinemuri River compares with both the existing consented standard, and when compared to the ANZG (2018) trigger DGVs.

It is evident, that for the most part, the summary of the water quality of the Ohinemuri River, over the sampling period, shows that the median values of the parameters met the consent requirements. Similarly, except for silver, median values of all remaining parameters meet the ANZG (2018) trigger DGVs. We note that the DGV value for silver is below the detection limit, effectively making compliance with the DGV impossible.

20.1.5 Predicted Ohinemuri River Water Quality Compliance

20.1.6 Water Quality

GHD (2022A) provides modelled maximum daily mean and modelled maximum concentrations of the consented trace elements within the Ohinemuri River, and we repeat these in Table 36 below. Most elements model a mean and maximum concentration at least one order of magnitude below the consented limits ensuring there is significant buffer available to account for any underestimation of discharge concentrations. Based on these predictions GHD (2022A) concludes that water quality of the Ohinemuri River receiving environment will be compliant with the current consented water quality conditions.

20.1.7 Mass Loads

GHD (2022A) also reports on the mass loads for individual elements of water quality and concludes that all water quality elements are within the mass load limits of the existing consent. We understand that if discharge concentrations approach the consented concentrations for the operational regime, the RO plant can always be utilised to further improve the treatment process and is a contingency measure available to OGNZL.

We note that, based on the calculated contaminant mass load at OH6, GHD (2022A) has calculated the proportion of load attributable the WTP discharge and natural background.

Where the WTP discharge and natural background load do not account for the full contaminant load observed at OH6, the additional load is assumed to be from a combination of uncaptured seepage / runoff from current site operations and other potential non-mining sources.

GHD (2022A) calculated these loads where flow data and water quality align at the various monitoring locations throughout the 2019 period with data points covering a range of different flow conditions. For most trace elements (i.e. Sb, Ni, Zn and Se) the calculated difference is negligible (< 0.2 kg/day).

However, GHD (2022A) did note that for manganese and sulphate there is a distinct pattern of additional calculated loadings at most flow levels suggesting that another source apart from the known sources is possible.

Table 36: *Consented receiving environment water quality and modelled water quality at sample location OH6 of the Ohinemuri River (from GHD 2022).*

	OH6 (Modelled Data)		Consented Receiving Water Quality	
Chemical Parameter	**Maximum Daily Mean**	**Max**	**Hardness 20 g/m³ $CaCO_3$**	**Hardness 100 g/m³ $CaCO_3$**
pH	Not Modelled		6.5 – 9.5	
Temperature	22.6	26.8	<3°C Rise	
Cyanide, WAD (g/m³)	0.004	0.018	0.093	0.093
Iron (g/m³)	0.30	0.46	1.0	1.0
Manganese (g/m³)	0.036	0.059	2.0	2.0
Copper (g/m³)	0.0011	0.0031	0.003	0.011
Nickel (g/m³)	0.0033	0.0033	0.04	0.160
Zinc (g/m³)	0.0040	0.0062	0.027	0.100
Silver (g/m³)	< 0.0001	< 0.0001	0.00025	0.00284
Antimony (g/m³)	0.0027	0.0058	0.030	0.030
Arsenic (g/m³)	0.0028	0.0050	0.190	0.190
Selenium (g/m³)	0.0011	0.0023	0.020	0.020
Mercury (g/m³)	< 0.00008	< 0.00008	0.000012	0.000012
Cadmium (g/m³)	0.0003	0.0005	0.0003	0.001
Chromium VI (g/m³)	< 0.01	< 0.01	0.01	0.01
Lead (g/m³)	0.0001	0.0002	0.0004	0.0025
TSS (g/m³)	Not Modelled		+10 g/m³ compared to upstream where upstream < 100 g/m³ or <10% increase	
Ammonia (g/m³)	0.89	1.93	0.189 – 3.0[1]	
Major cations / Anions				
Ca^{2+}	167	333	N/A	
Mg^{2+}	36	44	N/A	
Na^{+}	35	44	N/A	
K^{+}	7	12	N/A	
SO_4^{2+}	660	1033	N/A	

*Trace element concentrations are dissolved
*Where all samples of the monitoring period were below the mdl, the concentration is given as <mdl. Otherwise the mdl is used as the concentration for the specific sample.
1. Dependent on temperature and pH (Table 2 of RC 971323).

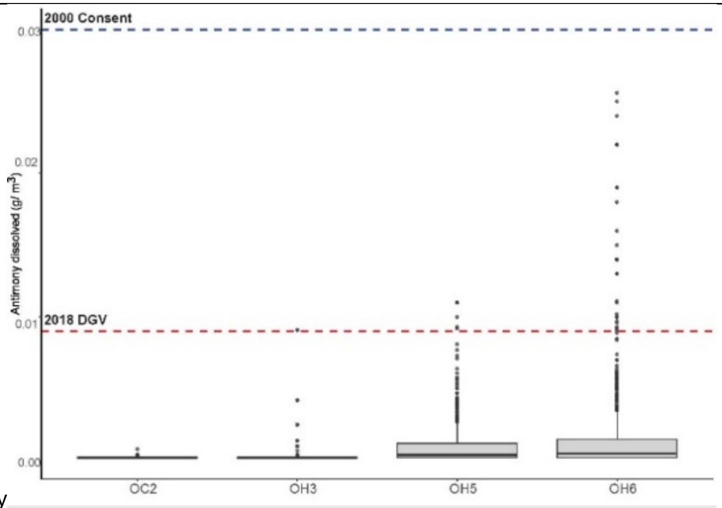
20.1.8 Effects of Water Quality Criteria on Ecological Values

We have outlined the water quality and ecological values of the Ohinemuri River in section 13 above. We have demonstrated that over the period of the operations at OceanaGold Waihi the ecological values of the Ohinemuri River have remained stable and persistent. OGNZL continues to demonstrate compliance with the consent conditions by carrying out monitoring and any repeat sampling and investigations required by the treated water discharge permit. Our review of this monitoring data shows that mining operations at Waihi continue to meet the required receiving water quality standards[38] with no detriment or adverse effect to the ecological values of the Ohinemuri River.

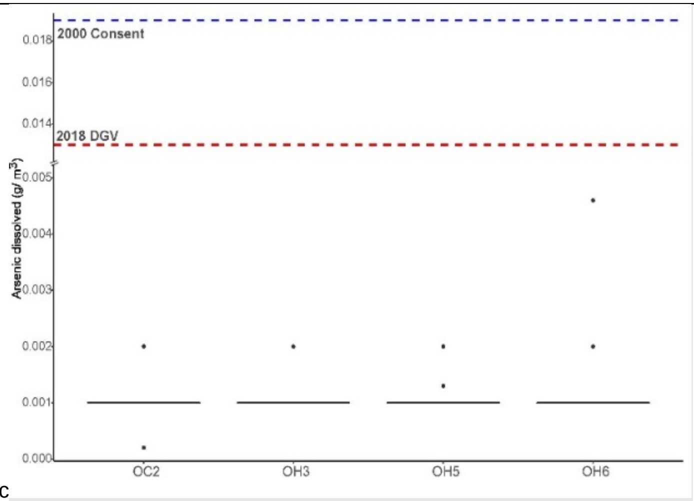
[38] As set out in WRC resource consent conditions 971285, 971311, 971312, 971303-971306 and 971323

We also conclude that as there is no evidence that the effect of the discharge on water quality has caused any detrimental effects to the ecological values of the Ohinemuri River, and the ecological values have been maintained as anticipated by the criteria as set out in the consent conditions.

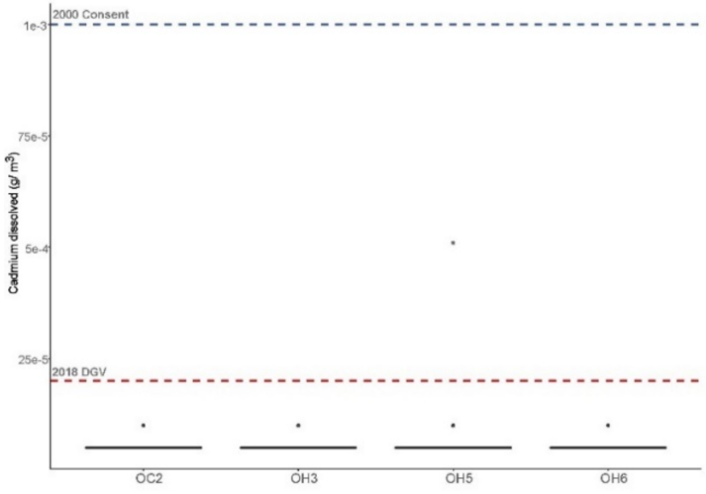
Modelling from GHD (2022A) has concluded that water quality of the Ohinemuri River receiving environment will be compliant with the current consented water quality conditions, and that mass loads will be within the implied mass load limits of the existing consent requirements.



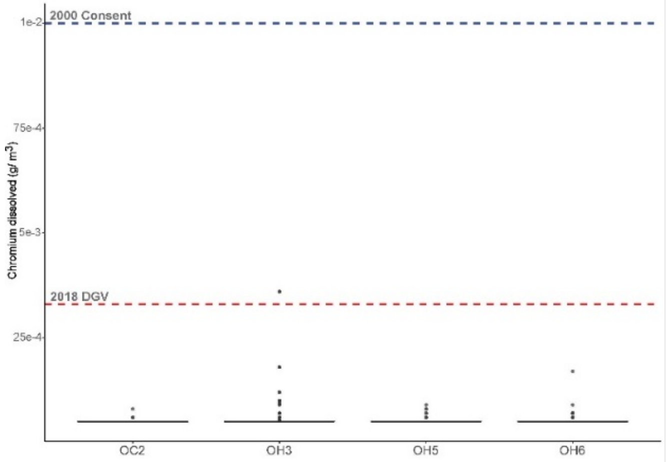
Antimony



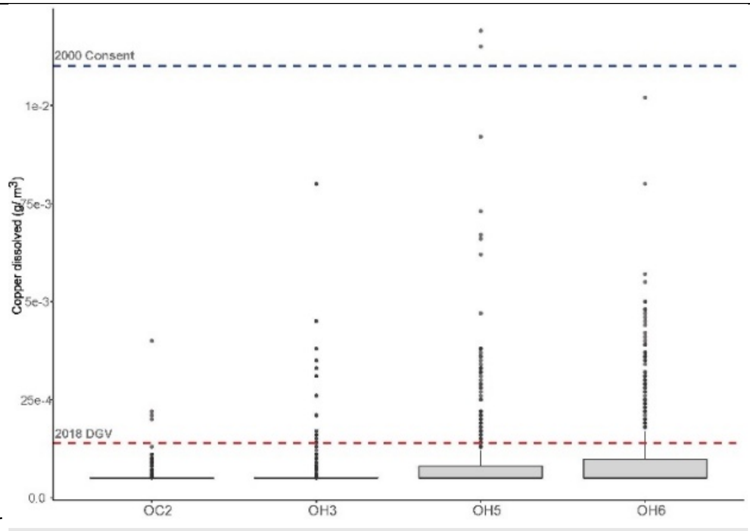
Arsenic



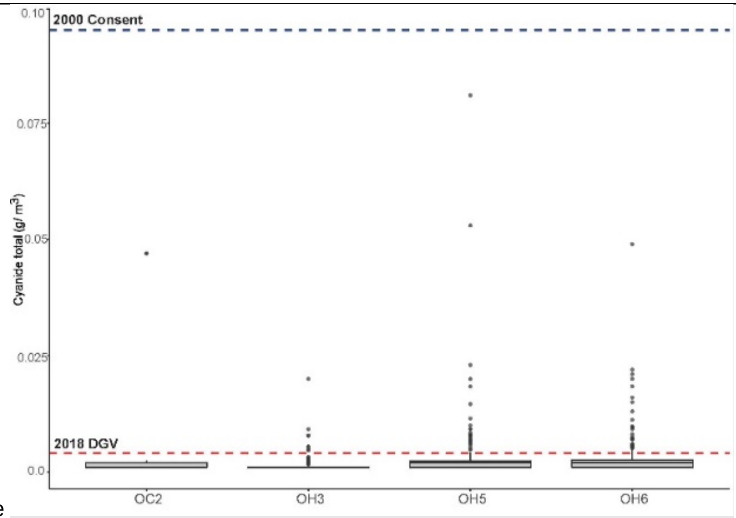
Cadmium



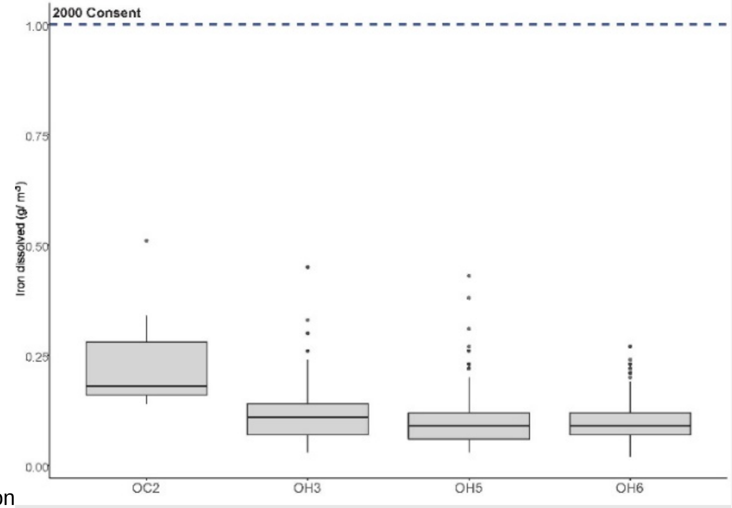
Chromium VI



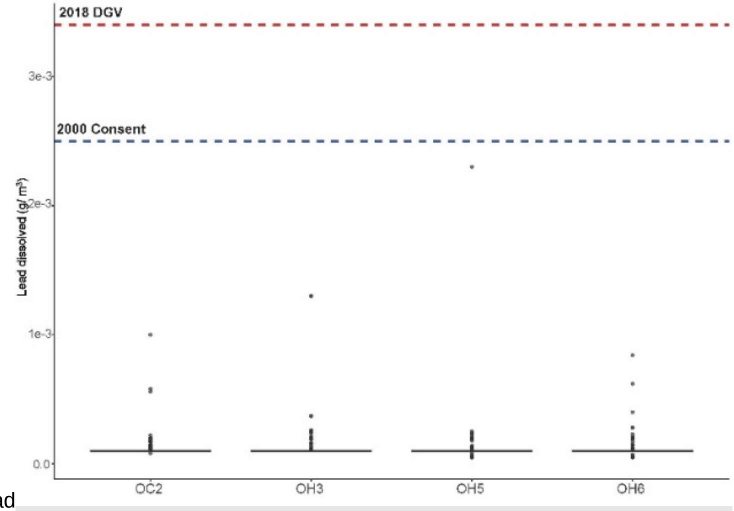
Copper



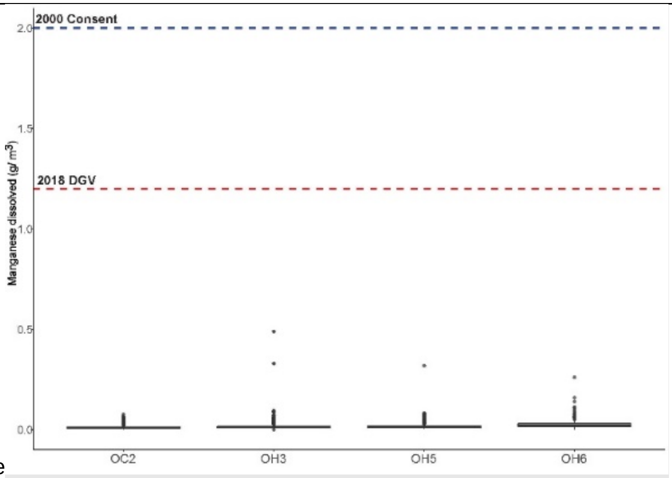
Cyanide



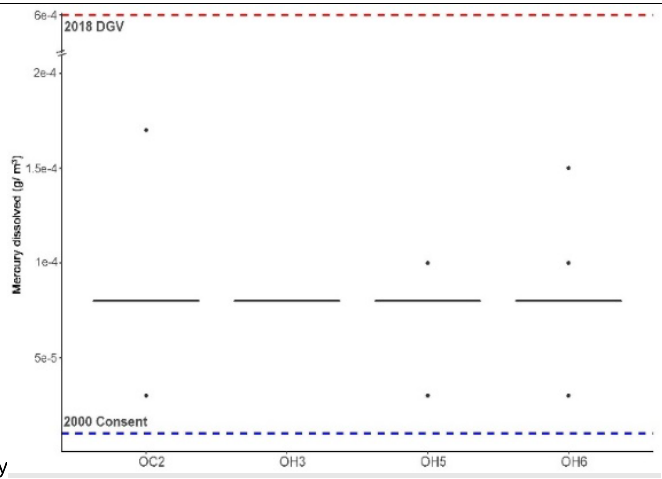
Iron



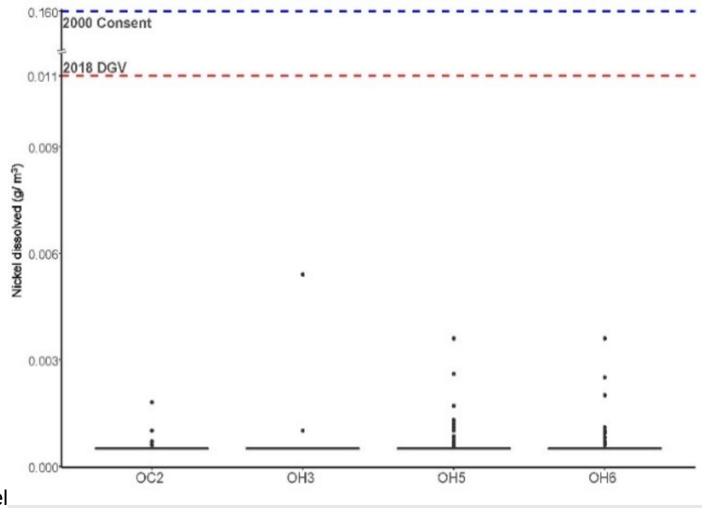
Lead



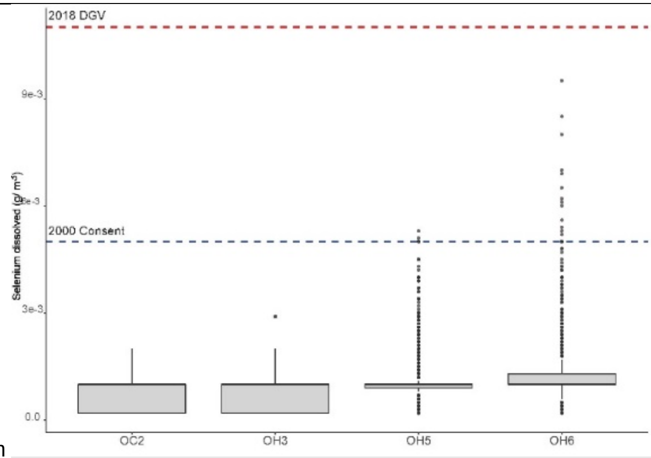
Manganese



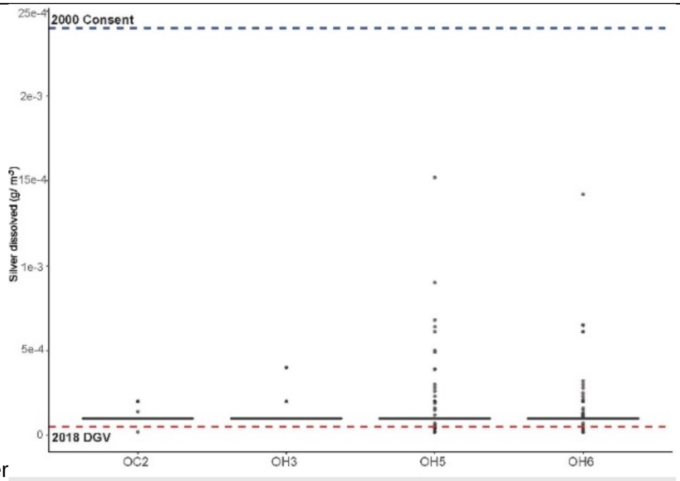
Mercury



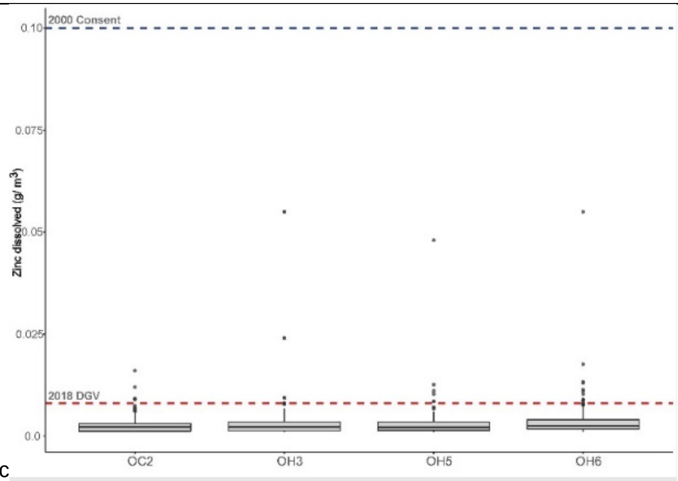
Nickel



Selenium



Silver



Zinc

Figure 31: *Summary boxplots of water quality of the Ohinemuri River at four locations, 2008-2021. See Appendix 7 for interpretation of boxpl*

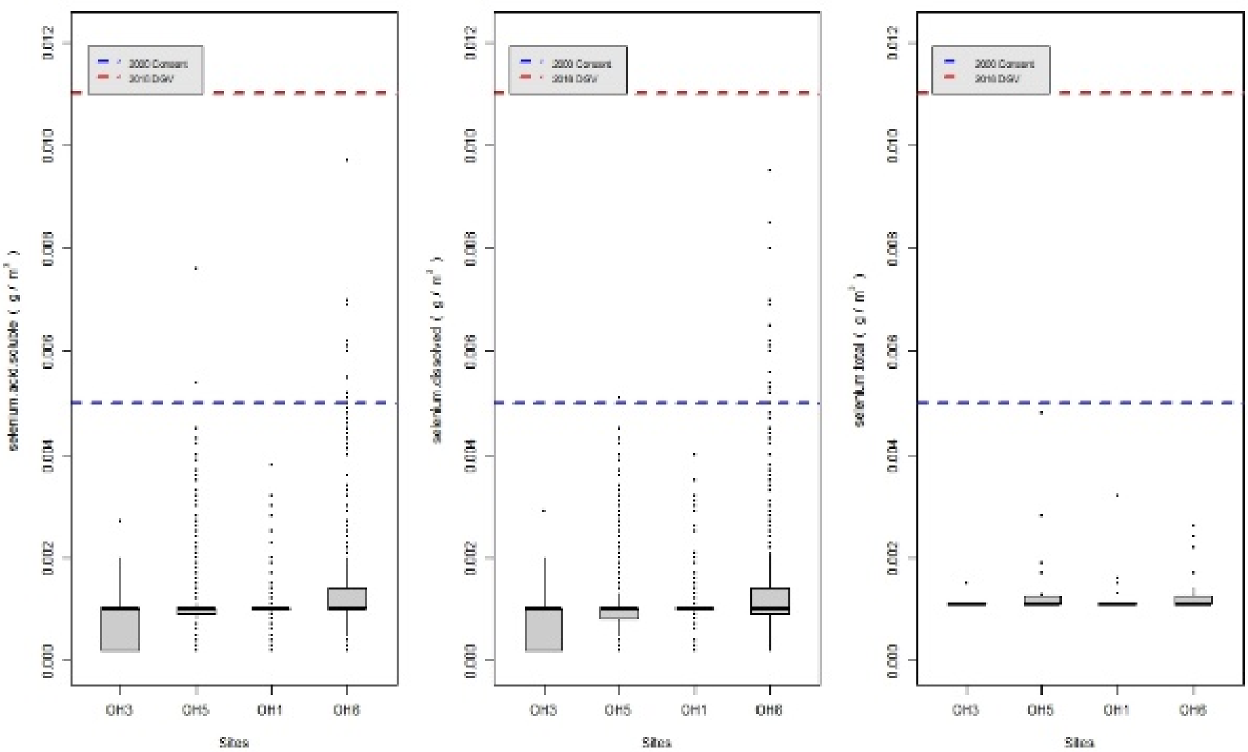


Figure 32: *Summary boxplots of water quality of the Ohinemuri River at four locations, 2010-2021. See Appendix 7 for interpretation of boxplots.*

20.1.9 Treated water discharge and NOF

20.1.10 Ammoniacal Nitrogen

NOF limits

The NOF sets out ammonia limits for ecosystem health (water quality) for freshwater in New Zealand. These limits relate to ammonia toxicity and are set out in attribute bands for condition of water quality in relation to ecosystem health. The limits for each attribute band are set out for the protection of species in the community (e.g., 99% species protection; no observed effect on any species tested). The NOF attribute bands are set out in Appendix 12.

Ammoniacal Nitrogen in the Ohinemuri River

We have set out the concentrations of ammoniacal nitrogen recorded from the Ohinemuri River at Waihi as the numeric attribute state limits of the NOF (i.e. annual median and annual maximum) in Table 37. It is evident that the Ohinemuri River meets Attribute A for the annual median at sites upstream at Waihi, but for the most part is within Attribute B in the lower reaches of the river at Waihi (and below the NBL in 2016 and 2018).

For the annual maximum of the sample record, the river was in Attribute B (occasionally Attribute A) upstream of the treated water discharge and below the NBL downstream at Waihi (occasionally Attribute B).

Ammoniacal Nitrogen in the treated water discharge

In their modelling of the treated water discharge for WNP, GHD (2022b) predicted that maximum daily mean concentration of ammonia at the most downstream site at Waihi (site OH6) would be 0.89 g/m^3 and the maximum concentration would be 1.93 g/m^3 and would be within current consent limits.

Effects of Ammoniacal Nitrogen on aquatic ecological values

We have noted above that the water quality of the Ohinemuri River falls from Attribute band A above the treated water discharge to Attribute band B at sites below the discharge for annual median for ammoniacal nitrogen but falls below the NBL below the discharge for the annual maximum. NOF Attribute band B is set for the 95% species protection level (starts impacting occasionally on the 5% most sensitive species); Attribute band A is set at the 99% species protection level.

We note that the results for the annual maximum for ammoniacal nitrogen downstream of the treated water discharge all fall within the Attribute band C (below NBL), providing 80% species protection (i.e. starts impacting regularly on the 20% most sensitive species, but not at acute level (Attribute D).

We also note that the NPS-FM numeric attribute state for each band for ammoniacal nitrogen is based on a pH 8 and a temperature of 20ºC. The data reported above and provided in Table 35 has not been adjusted for these parameters.

20.1.11 Nitrate

Background

Nitrate nitrogen is a nutrient that is necessary for algae and macrophyte (plant) growth. In excessive concentrations in freshwater, it can result in nuisance growths of these plant forms, especially where phosphorus is also in excess. At higher concentrations, nitrate can be toxic to aquatic life.

NOF limits

The NOF sets out limits for nitrate for ecosystem health for freshwaters (rivers) in New Zealand. These limits relate to nitrate toxicity limits and are set out in attribute bands for condition of water quality for ecosystem health. The limits for each attribute band are set out for the protection of species in the community (e.g., 99% species protection; no observed effect on any species tested). The NOF attribute bands for nitrates are set out in Appendix 12.

Nitrate in the Ohinemuri River

We have set out the concentrations of nitrate recorded from the Ohinemuri River at Waihi as the numeric attribute state limits of the NOF (i.e. annual median and annual maximum) (Table 38). It is evident that for the most part over the record of data available that water quality of the

Ohinemuri River meets Attribute A for the annual median and annual 95th percentile for nitrate at all sites of the river at Waihi. The treated water discharge is not contributing to any changes in the nitrate concentrations in the Ohinemuri River.

20.1.12 Dissolved Reactive Phosphorus (DRP)

NOF limits

The NOF sets out limits for DRP for ecosystem health (water quality) for freshwaters (rivers) in New Zealand. These limits relate to DRP limits and are set out in attribute bands for condition of water quality for ecosystem health that require an Action Plan. In the case of DRP no NBL has been set. The limits for each attribute band are set out based on impacts on ecological communities, changes in primary production, macroinvertebrate and fish communities, and respiratory and decay rates. The NOF attribute bands for DRP are set out in Appendix 12.

DRP in the Ohinemuri River

We have set out the concentrations of DRP recorded from the Ohinemuri River at Waihi as the numeric attribute state limits of the NOF (i.e. annual median and 95^{th} percentile derived from monthly monitoring over five years) in Table . It is evident that for the most part over the record of data available that water quality of the Ohinemuri River meets Attribute A for the median and 95^{th} percentile for DRP at all sites of the river at Waihi. The treated water discharge is not contributing to any changes in the DRP concentrations in the Ohinemuri River.

20.1.13 Dissolved oxygen

NOF limits

The NOF sets out limits for dissolved oxygen for ecosystem health (water quality) for freshwaters (rivers) in New Zealand (specifically for below points sources). In the case of dissolved oxygen, the NBL has been set as 5.0 g/m^3 (7-day mean minimum over the summer period), and 4.0 g/m^3 (1-day minimum over the summer period). The limits for each attribute band are set out based on stress levels on aquatic organisms. The NOF attribute bands for dissolved oxygen are set out in Appendix 12.

Dissolved oxygen in the Ohinemuri River

Records for DO within the Ohinemuri River at Waihi are limited, and at best only available from 2003 to 2010, and then only as spot temperatures. It is difficult to draw meaningful conclusions from such a sparse data set. Furthermore, the data is not collected as the same numeric measures required for the NOF (7-day mean minimum and 1- day minimum) as no continuous oxygen monitoring has been undertaken or is required as a condition of the current consents. Nevertheless, we provide the available dissolved oxygen data in Table 40.

Spot recordings are generally a poor representation of what is happening with DO in the river as DO typically varies over a 24-hour period as it responds to the biotic and abiotic factors within the river system. DO is generally highest during afternoons when photosynthetic activity is at its greatest (excess DO production over DO use through respiration) and DO is lowest shortly before dawn when productivity is at its lowest (DO demand from respiration is occurring in the absence of DO-producing photosynthesis). In addition, DO levels occur in an inverse relationship with temperature, i.e. as temperature levels increase less DO is available.

We consider that although lowered DO levels have the potential to result in adverse effects on the aquatic values there is no evidence to suggest that low DO levels have in fact resulted from the treated water discharge and resulted in any adverse effects on the aquatic ecological values within the Ohinemuri River at Waihi. Nevertheless, we have recommended a condition of consent that requires the collection of DO (and temperature) data during summer low flows to inform an understanding of any changes that may occur in the Ohinemuri River in the vicinity of the treated water discharge and to inform future catchment plans and initiatives.

Table 37: *Annual maximum and annual median data for* ***ammoniacal nitrogen NH_4-N*** *(g/m^3) across four sites sampled in the Ohinemuri River at Waihi from 2003-2021. Measures are colour coded according to the NOF Attribute parameters that they fall within (NPS-FM 2020): green = Attribute A; yellow = Attribute B; red = Attribute C or Attribute D (both of which fall below the National Bottom Line for NH_4-N). Site locations are shown in Figure 14; NOF environmental limits are provided in Appendix 12.*

NOF Attributes	Annual Maximum	Annual Median
Attribute A (g/m^3)	<0.05	<0.03
Attribute B (g/m^3)	>0.05 - <0.40	>0.03 - <0.24
NBL (g/m^3)	**0.4**	**0.24**
Attribute C (g/m^3)	>0.4 - >2.2	>0.24 - <1.3
Attribute D (g/m^3)	>1.3	>2.2

Site	**OC2**		**OH3**		**OH5**		**OH6**	
NH_4-N (g/m^3)	Ann. Max	Ann. Med	Ann. Max	Ann. Med	Ann. Max	Ann. Med	Ann. Max	Ann. Med
2005					0.440	0.030	0.430	0.070
2006	0.050	0.020			0.490	0.060	0.530	0.160
2007	0.040	0.014			0.290	0.080	0.580	0.145
2008	0.096	0.010	0.280	0.010	0.450	0.074	1.500	0.220
2009	0.089	0.010	0.160	0.010	1.20	0.220	0.820	0.180
2010	0.062	0.0115	0.082	0.0121	0.240	0.036	0.960	0.144
2011	0.142	0.010	0.080	0.010	0.910	0.129	0.960	0.124
2012	0.106	0.011	0.090	0.0115	1.000	0.125	1.010	0.090
2013	0.042	0.010	0.167	0.0115	0.430	0.0965	0.570	0.0865
2014	0.090	0.010	0.083	0.010	0.480	0.1185	0.440	0.052
2015	0.085	0.010	0.017	0.010	1.200	0.1195	0.410	0.0525
2016	0.128	0.010	0.042	0.010	1.200	0.570	0.960	0.410
2017	0.107	0.010	0.034	0.0105	0.610	0.195	0.670	0.1045
2018	0.063	0.010	0.113	0.0125	0.560	0.250	0.470	0.1030
2019	0.220	0.010	0.230	0.0105	1.040	0.189	0.690	0.1970
2020	0.043	0.010	0.032	0.010	0.730	0.047	0.620	0.0340
2021	0.079	0.010	0.092	0.010	0.420	0.138	0.210	0.0970

Table 38: *Annual maximum and annual 95th percentile data for* ***nitrate*** NO_3 *(g/m*^{3}*) across four sites sampled in the Ohinemuri River at Waihi from 2003-2021. Measures are colour coded according to the NOF Attribute parameters that they fall within (NPS-FM 2020): green = Attribute A; yellow = Attribute B; red = Attribute C or Attribute D (both of which fall below the National Bottom Line for* NH_4*-N). Site locations are shown in Figure 14; NOF environmental limits are provided in Appendix 12.*

NOF Attributes	Annual Median	Annual 95th Percentile
Attribute A (g/m^3)	<1.0	<1.5
Attribute B (g/m^3)	>1.0 x <2.4	<1.5 x <3.5
NBL (g/m^3)	**2.4**	**3.5**
Attribute C (g/m^3)	>2.4 x <6.9	>3.5 x >9.8
Attribute D (g/m^3)	>6.9	>9.8

Site	**OC2**			**OH3**			**OH5**			**OH6**		
NO_3 (g/m^3)	Ann. Med	Ann. 95%	n	Ann. Med	Ann. 95%	n	Ann. Med	Ann. 95%	n	Ann. Med	Ann. 95%	n
2005							0.911	1.195		1.020	1.3725	
2006	1.060	1.166					0.655	1.160		0.914	1.315	
2007	0.606	0.759					0.746	1.072		0.9605	1.2615	
2008	0.330	1.100		0.770	1.100		0.510	1.200		0.950	1.310	
2009	0.590	1.00		0.700	1.00		0.915	1.300		0.970	1.215	
2010	0.490	1.071		0.490	1.1525		0.485	1.234		0.920	1.3975	
2011	0.700	1.0145		0.700	1.115		0.880	1.115		0.975	1.1645	
2012	0.580	1.008		0.590	1.0185		0.880	1.249		1.095	1.524	
2013	0.610	1.060		0.545	1.3365		0.760	1.302		0.925	1.2605	
2014	0.340	0.883		0.365	0.9365		0.570	0.967		0.520	1.065	
2015	0.405	0.855		0.390	0.829		0.685	1.210		0.770	1.184	
2016	0.670	1.016		0.655	1.0205		0.900	1.184		1.060	1.273	
2017	0.710	1.145		0.755	1.4295		0.960	1.185		1.000	1.277	
2018	0.650	1.188		0.590	1.158		0.970	1.246		1.070	1.312	
2019	0.500	0.791		0.420	0.824		0.680	0.993		0.740	1.0715	
2020	0.150	1.369		0.180	1.640		0.390	1.953		0.630	1.962	
2021	0.380	0.904		0.520	0.895		1.400	1.865		1.230	1.929	

Table 39: *Five-yearly median and 5-yearly 95th percentile data for* ***dissolved reactive phosphorous DRP*** *(g/m^3) across four sites sampled in the Ohinemuri River at Waihi from 2003-2021. Measures are colour coded according to the NOF Attribute parameters that they fall within (NPS-FM 2020): green = Attribute A; yellow = Attribute B; red = Attribute C or Attribute D (both of which fall below the National Bottom Line for NH_4-N). Site locations are shown in Figure 14; NOF environmental limits are provided in Appendix 12.*

NOF Attributes	5 Year Median	5 Year 95th Percentile
Attribute A (g/m^3)	<0.006	<0.021
Attribute B (g/m^3)	>0.006 - <0.010	>0.021 - <0.030
Attribute C (g/m^3)	>0.010 - < 0.018	>0.030 - <0.054
Attribute D (g/m^3)	>6.9	>9.8

Site	OC2		OH3		OH5		OH6	
DRP (g/m3)	5yr Median	5yr 95%ile	5yr Median	5yr 95%ile	5yr Median	5yr 95%ile	5yr Median	5yr 95%ile
2003-2007					0.00560	0.0252		
2004-2008					0.00460	0.02400	0.00400	0.01760
2005-2009					0.00490	0.01910	0.00460	0.01820
2006-2010	0.00475	0.02475			0.00485	0.01805	0.00400	0.02200
2007-2011	0.00460	0.02445			0.00460	0.01620	0.00400	0.02070
2008-2012	0.00460	0.02310	0.00520	0.02175	0.00450	0.01590	0.00400	0.01180
2009-2013	0.00460	0.01580	0.00520	0.01700	0.00400	0.01180	0.00400	0.008675
2010-2014	0.00400	0.02410	0.00400	0.01780	0.00400	0.01235	0.00400	0.00700
2011-2015	0.00400	0.01700	0.00400	0.01400	0.00400	0.00955	0.00400	0.00600
2012-2016	0.00400	0.01510	0.00400	0.01500	0.00400	0.00850	0.00400	0.00670
2013-2017	0.00400	0.01500	0.00400	0.01005	0.00400	0.00930	0.00400	0.00700
2014-2018	0.00500	0.01510	0.00400	0.00980	0.00400	0.00930	0.00400	0.00670
2015-2019	0.00450	0.01000	0.00400	0.00900	0.00400	0.00800	0.00400	0.00680
2016-2020	0.00400	0.01000	0.00400	0.00900	0.00400	0.00800	0.00400	0.00700
2017-2021	0.00400	0.00925	0.00400	0.00895	0.00400	0.00800	0.00400	0.00600

Table 40: *Annual median and summer minimum data for* ***dissolved oxygen DO*** *(g/m³) across four sites sampled in the Ohinemuri River at Waihi from 2003-2010. Summer data is taken from any recordings during the periods spanning from 1st November to 30th April. Measures are colour coded according to the NOF Attribute parameters that they fall within (NPS-FM 2020): green = Attribute A; yellow = Attribute B; red = Attribute C or Attribute D (both of which fall below the National Bottom Line for NH_4-N). Note that annual minimum is not a NOF limit. Site locations are shown in Figure 14; NOF environmental limits are provided in Appendix 12.*

NOF Attributes	Annual Median	Summer Minimum
Attribute A (g/m³)		<7.5
Attribute B (g/m³)		>5.0 - <7.5
Attribute C (g/m³)		>4.0 - <5.0
NBL (g/m3)		**4**
Attribute D (g/m³)		<4.0

Site	**OC2**		**OH3**		**OH5**		**OH6**	
DO (g/m3)	Ann. Min	Summer Min	Ann. Min	Summer Min	Ann. Min	Summer Min	Ann. Min	Summer Min
2003					9.7	7.4		
2004					7.4	9.1	9.5	7.0
2005					8.5	8.0	6.6	8.3
2006	8.8	8.4			6.3	6.3	8.1	7.5
2007	8.4	8			7.8	7.1	7.5	7.5
2008	7.6	6.1	6.4	6.3	7.1	7.4	7.5	6.4
2009	6.1	9.2	6.3	8.1	4.1	4.7	3.6	4.1
2010	8.7		8.1	9.4	4.7	9.6	4.1	4.1

20.1.14 Effects of temperature on ecological values

20.1.15 Background

As temperature varies within both the treated water discharge and within the Ohinemuri River, here we provide an assessment of the potential effects of increased water temperature. In undertaking our assessment, we have drawn on existing records of temperatures of the treated discharge water and as recorded from the Ohinemuri River. Our assessment has also been informed by the available literature on the effects of temperature on freshwater organisms.

20.1.16 Temperature thresholds

Water temperature is important for a wide range of aquatic ecological functions, and alterations to temperature can have a range of different effects. Effects can occur over short to long periods of time, so duration is also important to consider. Many species have specific temperature thresholds for different stages of their life cycles and are adapted to temperature regimes. In addition, changes to temperature can result in modified biotic (e.g., competition/predation with introduced species) and food-web interactions.

A range of methods and approaches has been used to assess the thermal tolerance of aquatic organisms, ranging from knowledge of field distribution of species, particularly at temperature extremes to controlled laboratory experiments which provide the most defensible estimates of the thermal tolerance of aquatic species.

In a review of thermal tolerance in aquatic biota, AC (2012) outlines acute and chronic temperature thresholds for native fish and aquatic macroinvertebrates, including critical maximum temperatures, temperature preferences, and upper limits of behavioural and development effects. Based on the criteria, the AC (2012) assessment of temperature thresholds conclude that:

- Maximum temperatures in upland streams that are less than 20°C should protect even the most sensitive native taxa.
- The most sensitive native taxa in lowland streams should be protected as long as maximum temperatures are less than 25°C.

Thermal tolerance of a range of fish species is shown in Table 41: and for fish and macroinvertebrates in Figure 33. The effects of the proposed reduced environmental flows on water temperature will be influenced by several key factors including (but not limited to):

- The extent of reduction in wetted area and depth of the receiving watercourse.
- The extent of shading available to the surface waters of the watercourse.
- The temperature of the source of water for the environmental flows.

We note that the maximum temperature thresholds distinguish upland and lowland streams. The Ohinemuri River at Waihi is some distance upstream from the coastline but retains a more lowland character with flow and gradient, notably within the Waihi Basin.

20.1.17 Potential temperature attribute thresholds

There are no attribute tables for temperature within the NOF. However, NIWA (2013) proposed potential thresholds for temperature for the NOF and we comment briefly on these recommendations here. We emphasise that such limits have no regulatory standing, but they do capture the results of analysis of temperature for NZ waters and are informative in considering temperatures within the Ohinemuri River.

The comprehensive review of temperature criteria for New Zealand native fauna by AC (2012, Table 41) as discussed above provided the basis for proposing tentative temperature limits in NIWA (2013). An Attribute band A/B ('no effect') threshold of 18ºC was proposed and an Attribute band C/D ('bottom line') limit of 24ºC was proposed. The recommendation allowed that the natural thermal regime of streams in eastern dry regions may be hotter than in more maritime climates, with a (nominal) 1ºC increase in absolute temperature limits in the former. Further refinement of (local) limits would require normalising to reference sites. Accordingly, NIWA (2013) proposed limits for temperature increments above reference stream high temperatures that may be used instead of absolute limits where appropriate data is available.

Table 41: *Thermal growth optimum predicted from the upper lethal temperatures (acclimation temperature 15℃ or 16℃ for species marked *). From ARC 2012.*

Common name	Scientific name	Life stage	Upper lethal temperature	Predicted growth optimum
Shortfin eel	*Anguilla australis*	Elver	35.7	29.0
Shortfin eel	*Anguilla australis*	Adult	39.7	34.2
Longfin eel	*Anguilla dieffenbachii*	Elver	34.8	27.8
Longfin eel	*Anguilla dieffenbachii*	Adult	37.3	31.0
Cran's bully	*Gobiomorphus basalis*	Mixture	30.9	22.6
Common bully	*Gobiomorphus cotidianus*	Mixture	30.9	22.6
Torrent fish	*Cheimarrichthys fosteri*	Adult	30.0	21.4
Inanga	*Galaxias maculatus*	Adult	30.8	22.5
Giant kokopu	*Galaxias argenteus**	Whitebait	30.0	21.4
Banded kokopu	*Galaxias fasciatus*	Adult	28.5	19.5
Koaro	*Galaxias brevipinnis**	Juvenile	28.0	18.8
Common smelt	*Retropinna retropinna*	Adult	28.3	19.2

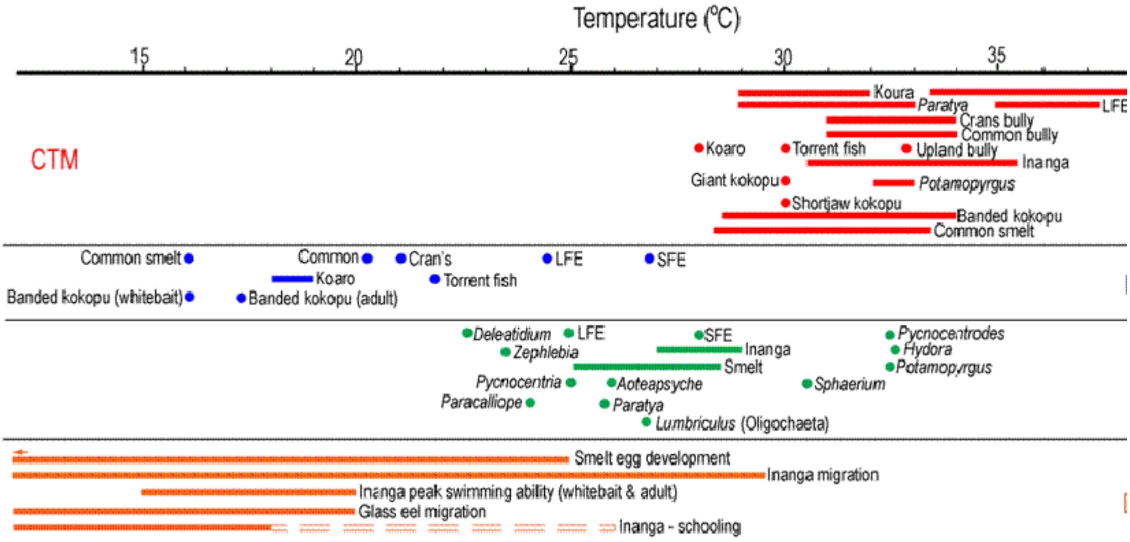


Figure 33: *Summary of thermal tolerance of native fish and macroinvertebrates as expressed by critical thermal maxima (CTM - red), thermal preferences (blue), upper incipient lethal temperature (UILT – green) and behavioural and developmental effects (orange). From ARC (2012).*

20.1.18 In-river and discharge temperatures

Weekly (and often irregular) water temperature data has been collected from the Ohinemuri River from 2006. In this section we report on this data to assess the longer-term nature of temperature within the river.

Daily single temperature records show that temperature of the temperature ranges from 12.7ºC to 30.4ºC[39].

In-river temperatures from the four sites ranged from 7.9ºC (sites OC2, OH3 and OH5) to 27.9ºC (site OH5) and median values ranged from 14.8 (sites OC2 and OH3) to 15.9 (OH6) (Table 42).In-river temperatures rarely exceeded 25ºC (occurring on only two occasions over the temperature record) but exceeded 20ºC on several occasions (up to 117 occasions within the temperature record). The higher threshold temperatures exceedances occurred at the downstream sites at all temperature bands (>20ºC up to >25ºC) (Table 43).

In-river temperature differences between sites above and below the discharge recorded by spot sampling on the same days are shown in Table 32. We note that there is a time-of-day sampling disparity on each daily record of 2-3 hours (that is the samples were not collected at the same time of day on each occasion). Temperature differences of >3ºC occurred on only two occasions over the sample period, and >2ºC on 21 occasions (Table 44).

[39] We note that the discharge temperature records show that temperature was elevated (40.6ºC - 43.4ºC) for 12 days during June 2018. As the temperature records during this time are clearly outliers, probably due to failure of temperature loggers, we have removed them from our data summary.

Table 42: *Summary statistics of discharge and in river water temperature (℃) in the Ohinemuri River. Site locations shown in Figure 14.*

	Location				
Statistic	**Discharge (℃)**	**OC2 (℃)**	**OH3 (℃)**	**OH5 (℃)**	**OH6 (℃)**
Summary for all year temperature record					
Mean	21.9	15.3	15.4	16.1	16.3
Median	22.3	14.8	14.8	15.8	15.9
Minimum	12.7	7.9	7.9	7.9	8.5
Maximum	30.4[#]	24.5	24.8	27.9	25.8
n	1206	628	889	801	782
Sample period	2014-2018	2006-2021	2008-2021	2003-2021	2004-2021
Summary for critical summer temperature period (1 January to 30 March)					
Mean		19.3	19.2	20.1	20.6
Median		19.3	19.4	20.3	20.7
Minimum		13.5	13.5	13.9	13.8
Maximum		24.5	24.8	27.9	25.2
n		138	107	168	167
Sample period	2014-2018	2008-2021	2008-2021	2008-2021	2008-2021

[#] Outlier discharge temperatures ranging from 40.6℃ - 43.4℃ occurred for 12 days during June 2018 and we have removed this data from our summary

Table 43: *Number of records from four OGNZL monitoring sites within the Ohinemuri River over the critical summer period where temperatures have exceeded recommended temperature thresholds 20℃ to 25℃ (AC 2012). Site locations shown in Figure 14.*

	Sample site			
Temperature exceedance	**OC2**	**OH3**	**OH5**	**OH6**
> 25℃	0	0	1	2
> 24℃	3	2	7	10
> 23℃	5	4	20	26
> 22℃	17	13	39	49
> 21℃	28	22	55	68
> 20℃	50	41	89	89
n	628	889	801	782
Sample period	2006-2021	2008-2021	2003-2021	2004-2021

Table 44: *Number of recorded temperature differences between upstream and downstream monitoring sites over the critical summer period (January – March inclusive) in the Ohinemuri River at Waihi. Site locations shown in Figure 14.*

Temperature change	OC2 and OH5	OC2 and OH6
> 3℃	4	6
> 2℃	16	21
> 1℃	16	21
n	124	122

20.1.19 Continuous temperature records 2019-2020

Background

Water temperature varies diurnally and seasonally and while both minimum and maximum temperatures can affect river health, maximum temperatures most often limit biota. Many published temperature limits for aquatic organisms are derived from laboratory-based experiments that expose organisms to constant temperature. Cox & Rutherford (2000) concluded that temperature limits should be applied to a temperature midway between the daily average and the daily maximum of a diurnal profile.

From this, the Cox-Rutherford Index (CRI) has been developed as the average of daily maximum and daily mean temperatures and provides a measure that permits application of (constant) temperature criteria (which are well developed for many species) to temperature regimes varying over a diel cycle in rivers (Cawthron 2019).

The CRI relies on continuous temperature data being collected at regular intervals (typically every 15 mins) over a period of time (several days or months, most helpfully over the summer period). Continuous temperature data was collected by OGNZL at the regular water quality sampling sites (Table 45) from 20 March 2019 to 30 April 2020.

In-river temperatures at Waihi

The continuous record from the Ohinemuri River show that CRI temperature ranged from 8.7ºC to 27.75ºC. The CRI for the discharge temperatures ranged from 21.93ºC to 22.48ºC during the same period. The highest in-river temperature was recorded at site OH5 but sites OH3 to OH6 along the river all showed similar maximum CRI temperatures (27.07ºC – 27.75ºC). Mean annual CRI temperatures were all slightly higher at sites OH5, OH1 and OH6 than those upstream. The CRI temperatures during the critical summer period reflected these same patterns (Table 45).

In-river CRI temperatures greater than the guideline value of 25ºC during the critical summer period occurred at all sites but occurred more frequently in the lower reaches of the Ohinemuri River at Waihi (sites below OC2) (Table). CRI daily temperature increases above 20ºC occurred at all sites but reflected the same pattern for annual CRI daily temperature records (Table 46).

Differences of >3ºC between sites for in-river daily CRI temperatures occurred on two occasions (between the two most distant sites OC2 and OH6), but records for >2ºC occurred between the upper and lower sites at Waihi more frequently (Table 47).

Table 45: *Summary statistics of discharge and in river water temperature CRI (ºC) in the Ohinemuri River. OC2A and OC2B are sites located approximately 20 m upstream and 20 m downstream respectively of the HDC potable water take from the Ohinemuri River. Site locations shown in Figure 14.*

	Location						
Statistic	**Discharge CRI (℃)**	**OC2A CRI (℃)**	**OC2B CRI (°C)**	**OH3 CRI (℃)**	**OH5 CRI (℃)**	**OH1 CRI (℃)**	**OH6 CRI (℃)**
Summary for all year temperature record (20 March 2019 – 30 April 2020)							
Mean	20.85	16.52	16.65	16.86	17.72	17.55	17.16
Median	21.11	15.84	15.88	15.89	16.94	16.74	16.47
Minimum	21.93	8.99	8.85	8.73	9.89	9.70	9.78
Maximum	22.48	25.30	26.05	27.31	27.75	27.51	27.07
n	391	408	408	408	408	408	408
	Summary CRI for critical summer temperature period (1 November to 30 April)						
Mean	25.49	19.83	20.15	20.66	21.32	21.24	20.35
Median	25.61	20.45	20.66	21.05	21.65	21.59	20.46
Minimum	16.72	13.90	13.75	13.27	13.59	13.96	13.78
Maximum	28.7	25.30	26.05	27.31	27.75	27.51	27.07
n	168	182	182	182	182	182	182

Table 46: *Number of records from OGNZL monitoring sites within the Ohinemuri River over the critical summer period (1 November 2019 to 30 April 2020) where daily temperature CRI has exceeded recommended temperature thresholds 20ºC to 25ºC. Site locations shown in Figure 14.*

	Sample site					
Temperature (CRI) exceedance	**OC2A**	**OC2B**	**OH3**	**OH5**	**OH1**	**OH6**
> 25℃	1	2	9	20	16	11
> 24℃	3	10	24	39	33	30
> 23℃	17	27	42	64	67	43
> 22℃	41	58	71	85	88	60
> 21℃	78	86	91	102	103	84
> 20℃	93	103	111	119	118	97
n	182	182	182	182	182	182

Table 47: *Number of recorded daily temperature CRI differences between upstream and downstream monitoring sites over the critical summer period (November to April inclusive inclusive) in the Ohinemuri River at Waihi. Site locations shown in Figure 14.*

CRI Temperature change	OC2B and OH5	OC2B and OH1	OC2B and OH6	OH3 and OH5	OH3 and OH1	OH3 and OH6	OH5 and OH6
> 3℃	1	0	2	0	0	1	0
> 2℃	22	11	22	0	0	7	1
> 1℃	107	100	66	47	26	46	8
n	182	182	182	182	182	182	182

Of note from these results is the comparison between OH3 and OH5 during the critical summer period. These sites are virtually on the same stretch of river (or a similar part of the river), less than 1 km apart, and with the treated water discharge between them. While there are several occasions where the temperature increase is >1ºC during the summer period, there are none >2ºC.

20.1.20 Effects of temperature on ecological values

The all-year median in-river temperature was below the critical thermal thresholds and lower than the optimum growth temperatures for most species (Figure 32). Median temperature during the critical summer period is at the lowland river threshold while maximum temperatures are occasionally above the recommended thermal threshold. However, we also note that the in-river critical summer temperatures were within the optimum range of fish species recorded, noting the absence of inanga, torrent fish, koaro and smelt within the Ohinemuri River at Waihi.

The in-river temperatures were less favourable for macroinvertebrate species, approaching or exceeding upper incipient lethal temperatures for some species commonly occurring within the river. However, as outlined above, the consent monitoring of the ecological values of the Ohinemuri River has shown that macroinvertebrates have continued to thrive in the river.

In-river temperatures during the critical summer period were mostly below the upper critical temperature of 25°C (for upland streams) with recorded exceedances occurring on only two occasions.

Despite these temperature statistics, we emphasise that our assessment of the Ohinemuri River at Waihi has shown that the ecological values (as demonstrated by fish, macroinvertebrate and periphyton communities) has remained stable and persistent. Whilst there is the potential of direct lethal impacts on the aquatic biota and/or impairments to productivity, recruitment or functionality, there is no evidence to suggest that this has occurred.

We note that there is a temperature differential between the upper and lower reaches of the Ohinemuri River at Waihi, with the in-river temperature consistently slightly higher in the lower reaches at Waihi. We have noted that a >2ºC event has occurred on 21 occasions between upstream and downstream sites respectively (amounting to some 17% of the existing critical summer temperature record) over a 15-year period of spot temperature records (acknowledging that time of day of spot temperature recordings can be highly variable). In-river temperature increases of >3ºC between upstream and downstream of the discharges has occurred on only six occasions over the critical summer period during that same time period.

Daily CRI temperatures recorded continuously over 2019-2020 also showed only two occasions where CRI temperature exhibited a >3ºC change from the uppermost (site OC2) and lowermost (site OH6) sites at Waihi. The number of >2ºC changes between upstream and downstream were much greater.

We emphasise that while temperature increases occur throughout the reach of the Ohinemuri River at Waihi, the in-river temperatures upstream are already at or above the temperature thresholds set out in AC (2012).

We consider that although temperature has the potential to result in adverse effects on the aquatic values there is no evidence to suggest that temperature has in fact resulted in any adverse effects on the aquatic ecological values (neither direct nor indirect effects) of the Ohinemuri River at Waihi.

We also note that are a wide range of factors that influence in-river temperatures including depth and clarity of the river water, width of the river, river flows, the degree of shading, the influence of other tributaries and other water sources.

As a consequence of the noted changes in temperature and likely other factors influencing this, we have recommended that a condition of consent that requires the collection of additional temperature data to inform an understanding of the temperature changes that occur in the Ohinemuri River in the vicinity of the treated water discharge[40].

20.1.21 Effects of sulphate on ecological values

20.1.22 Background

In their modelling of the treated water discharge for WNP, GHD (2022A) predicted that maximum daily mean concentration of sulphate at the most downstream site at Waihi would be higher than those already occurring within the river. Accordingly, here we make comment on the potential effects of increased sulphate on freshwater organisms.

20.1.23 Potential effects of sulphate on freshwater organisms

Sulphate[41] occurs naturally and ubiquitously in the aquatic environment, and is released by many aquatic, terrestrial and geological processes. As a result, natural concentrations of sulphate can vary depending on the prevailing catchment geology and hydrology.

Sulphate is considered one of the least toxic of the major ions present in surface waters and is often linked more to osmotic stress rather than sulphate toxicity itself. A recent global review of sulphate in freshwater ecosystems found that very little is known about the concentration thresholds at which sulphate becomes toxic (Zak et al. 2021). Nevertheless, tests of lethal and inhibitory concentrations of sulphate have also shown that sensitivity of aquatic organisms to sulphate is decreased with increasing water hardness (and chloride). It was also evident that the removal rate of sulphate increases with water temperature.

The reported range of concentrations for effects of sulphate on a range of aquatic organisms is wide (~137 to 3,231 g/m^3) depending on species, life-stage, type of test and water hardness. Little data is available for the effects of sulphate on New Zealand aquatic organisms. However,

[40] The proposed condition also has compliance thresholds.

[41] Sulphate is the anion of Sulphuric Acid.

some of the reported overseas concentrations that cause effects in some organisms are reached (here reported as annual median and annual maximum) within the Ohinemuri River at Waihi (Table). Notwithstanding specific water hardness measures at a point in time, we note that annual maximum in-river sulphate levels range from 4.1 to 580 g/m^3, and annual median ranges from 3.7 to 320 g/m^3 within the Ohinemuri River in the vicinity of Waihi. The range narrows slightly in the lower reaches below the OGNZL discharge at Waihi (67 to 580 g/m^3 for annual maximum, and 17 to 320 g/m^3). Notable increases in concentrations of sulphate are evident downstream of the treated water discharges.

In their review, Zak et al (2021) report sulphate concentrations that cause inhibitory and/or lethal effects on a variety of organisms. Most relevant to the aquatic ecological values of the Ohinemuri River are the concentrations that effect salmonids (rainbow trout (*Oncorhynchus mykiss*), embryo and fry). Reported concentrations for rainbow trout ranged from 174 g/m^3 (IC/LC 10[42]) at low water hardness (i.e. 6 mg $CaCO_3$/L) to 3,670 g/m^3 (IC/LC 50[43] at 100 mg $CaCO_3$/L). Sulphate concentrations effecting other aquatic organism survival (e.g., amphipods, molluscs, algae) were typically higher (cf. 1,759 g/m^3 for cladoceran *Ceriodaphnia dubia* (IC/LC 10), 1,502 g/m^3 for mollusc *Sphaerium simile* (IC/LC 10). On the other hand, sulphate concentrations were lower and within the range experienced within the Ohinemuri River for inhibitory effects on reproduction and/or embryos.

Ryder (2019b) reported toxicity testing for sulphate that has been conducted using Taieri flathead galaxias (*Galaxias depressiceps)*. The most sensitive stages of the flathead galaxias (eggs and larvae) were exposed to a range of concentrations of diluted mine waste rock seepage. The principal constituent of seepage is sulphate and the testing used sulphate concentrations ranging from 100 to 3,000 g/m^3. No impact was identified on ova and there was no evidence of a toxicity effect during any of the egg development stages. Actual mortality effects did not occur until sulphate concentrations of between 1,640 and 1,920 g/m^3.

Sulphate concentrations recorded downstream of the OGNZL discharge to the Ohinemuri River at Waihi are below these concentrations recorded as impacting on Taieri flathead galaxias survival, but exceed the concentrations set out by Zak et al. (2021) as inhibitory or lethal for rainbow trout embryo and fry. Accordingly, there is the potential for the sulphate levels within the treated wastewater discharge to result in concentrations downstream that may result in effects on rainbow trout and other aquatic organisms where they are present.

It therefore becomes apparent that effects will occur only where organisms sensitive to sulphate are present within the ecosystem. Trout embryos and fry were amongst the most sensitive organisms to sulphate that occur within the range of sulphate concentrations recorded from the Ohinemuri River at Waihi from Zak et al. (2021). Cladocerans were also sensitive to sulphate but this group of organisms are not typically found in fast flowing rivers such as the Ohinemuri River, although they may occur within the deeper slow-flowing pools.

We are not aware of trout spawning or trout fry activity in the mainstem reaches of the Ohinemuri River at Waihi, and consider that the tributary streams, including the Ruahorehore Stream are likely to be preferred locations for those functions.

In their modelling of the treated water discharge for WNP, GHD (2022A) predicted that maximum daily mean concentration of sulphate at the most downstream site at Waihi (site OH6) would be 660 g/m^3 and the maximum concentration would be 1,000 g/m^3. These predicted maximum concentrations are higher than those already occurring within the river.

[42] IC/LC 10 = Inhibitory concentrations affecting 10% of sample/experimental populations.
[43] IC/LC 50 = Inhibitory concentrations affecting 50% of sample/experimental populations.

As noted above, GHD (2022A) go on to state that there is a distinct pattern of additional calculated loadings at most flow levels for sulphate in the Ohinemuri River suggesting that another source apart from the known sources is possible.

Table 48: *Annual maximum and annual medium data for* ***sulphate SO_4^{2-}*** *(g/m^3) across four sites sampled in the Ohinemuri River at Waihi from 2005-2021. No attribute parameters for sulphate are outlined in the NPS-FM 2020. Figures are not adjusted for hardness. Site locations are shown in Figure 14.*

Site	**OC2**		**OH3**		**OH5**		**OH6**	
SO_4^{2-} (g/m^3)	Ann. Max	Ann. Med	Ann. Max	Ann. Med	Ann. Max	Ann. Med	Ann. Max	Ann. Med
2005					74.8	42.95	233.0	64.20
2006	23.8	10.0			109.0	56.00	139.0	82.35
2007	4.10	3.90			159.0	29.40	159.0	65.70
2008	6.20	3.80	17.0	4.30	88.0	17.00	190.0	74.50
2009	5.10	3.80	8.80	4.80	160.0	59.00	160.0	46.00
2010	5.20	3.70	8.20	5.30	67.0	24.00	260.0	116.0
2011	4.90	4.05	17.2	5.20	230.0	102.0	350.0	141.0
2012	4.70	4.05	16.2	4.50	350.0	108.0	330.0	86.50
2013	35.0	4.50	62.0	5.00	530.0	63.50	400.0	81.50
2014	6.00	4.00	16.0	5.00	300.0	121.0	240.0	119.5
2015	7.00	4.50	12.0	5.00	430.0	88.00	320.0	118.0
2016	15.0	4.00	48.0	5.50	210.0	131.5	270.0	115.0
2017	5.00	4.00	44.0	5.00	390.0	145.5	300.0	121.5
2018	6.00	4.50	6.00	5.00	320.0	156.0	250.0	126.0
2019	6.00	5.00	8.00	5.00	410.0	152.0	420.0	210.0
2020	9.00	5.00	9.00	5.00	410.0	210.0	520.0	320.0
2021	6.00	5.00	28.0	5.00	580.0	240.0	510.0	272.0

21.0 Treated water pipeline and outfall (Diffuser)

21.1.1 Introduction

As a result of the increased volume of discharge from the WTP it is necessary to provide appropriate outfall infrastructure. The proposed works are effectively a duplication of the existing pump station, pipeline alignments and outlet diffusers. The two new proposed 250 mm diameter pipelines will extend from the water treatment plant ponds to Ohinemuri River outfall locations #1 and #2 as shown in Figure 34.

21.1.2 Pipeline installation

The installation procedure for the pipeline is set out in Beca (2022a) as follows:

- The proposed discharge pipes are proposed to be installed via open trench construction at a 2 m offset (typical) from the existing discharge pipes (subject to existing site features and sensitive areas) as shown on the drawings.
- The pipes are delivered to site by truck and stockpiled in a dedicated laydown area. Sections of pipes are transported to the work front/s.
- Pipes are installed within an excavated trench. Soil removed would be and will be re-used as trench backfill after pipe laying.
- The length of open trenching shall be minimised by staging concurrent trenching, pipe laying, backfilling and stabilisation works to reduce exposed areas.
- The existing pipeline that runs beneath the future Gladstone pit stockpile is proposed to be relocated as shown on the drawings.
- Spoil-material would be temporarily stockpiled adjacent to the trench and re-utilised in backfilling of the trench. Excess material will be removed from the excavation site as soon as practical and stockpiled on OGNZL property.
- Reinstatement at ground level will match existing. Features removed to enable construction, such as fences, will be reinstated with temporary fencing installed during construction as required.

21.1.3 Effects of pipeline construction on aquatic ecological values

The new pipeline runs alongside the existing pipeline. The installation procedure is minimised through its staging, local temporary stockpiling and the limited open trenching. The pipeline route does not pass through any significant ecological areas, but it runs close to the Gladstone Wetland, and cuts through the riparian margin of the Ohinemuri River.

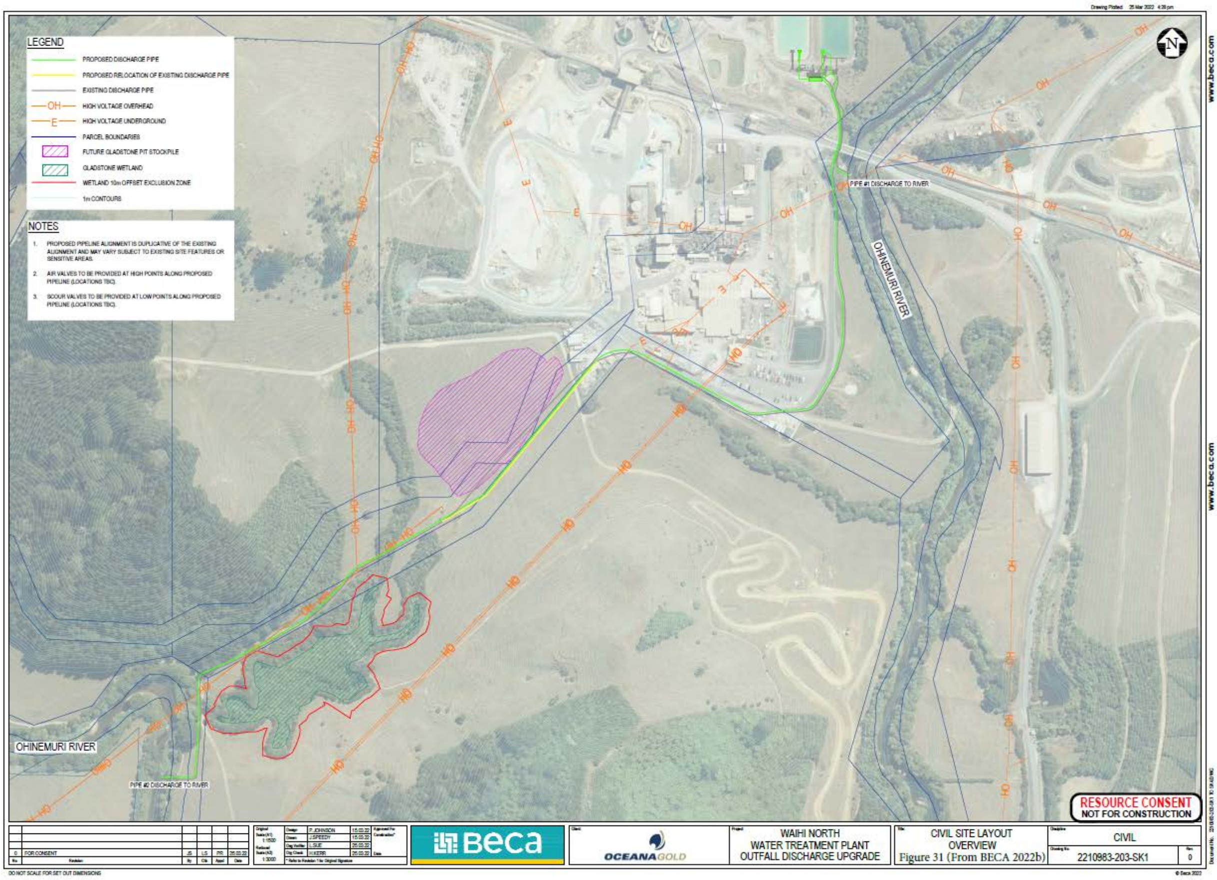


Figure 34: *Location of Pipelines and diffusers and proximity of pipeline to the Gladstone wetland.*

No construction or earthworks works will be carried out within 10 m of the Gladstone Wetland boundary (Figure 34). The ESCP proposed for the pipeline installation will prevent sediment entering the wetland.

As the pipeline follows the existing route no effects on the riparian planting alongside the Ohinemuri River is expected to occur.

Ecological effects resulting from the installation of the pipeline will be minimal.

21.1.4 Diffuser installation

The installation procedure for the diffuser is set out in Beca (2022) as follows:

- The proposed outlet diffusers will be installed approximately 2 m from the existing diffusers.
- A temporary cofferdam will be constructed to enclose the cast-in-situ concrete diffuser headwall construction area so that the construction can proceed in the dry. The river flow shall be maintained throughout construction.
- Prior to construction work beginning, silt curtains will be installed to the surrounding area to manage sediment disturbance during installation of the diffuser on the riverbed.

- A shallow depression within the riverbed will be created for the diffuser pipe to be placed within.
- The diffuser pipe and supports will be installed.
- Cast-in-situ shallow foundations will be constructed to anchor the diffuser pipe supports.
- The temporary bunding will be removed.

We understand that in addition to the ESCP, other necessary steps to control erosion and prevent sediment entering the waterways will be required e.g., construction of temporary berms and cutoffs, or stabilisation methods including use of clean aggregates, mulch, seeding, or geosynthetics and wheel washing facilities to prevent sediment leaving the site.

21.1.5 Effects of diffuser construction on aquatic ecological values

The proposed diffuser installation will be carried out during summer low flows, and there will be no disruption to the flow within the Ohinemuri River. During construction, the presence of a temporary coffer dam across part of the riverbed will allow the construction of the diffuser headwall to occur in the dry but will concentrate flows across a smaller width of river.

The narrower width of river means that there will be an increase in water velocities at this point across a small area of riverbed. As this will occur across a very small area of riverbed over a matter of days and during low flows this is not expected to result in any changes to the ecology of the riverbed. Fish passage will be maintained at all times.

The current diffusers will remain operational within the riverbed during construction of the new diffusers and all diffusers will be operational in discharging the treated water to the Ohinemuri River.

With the implementation of the ESCP and other recommended measures, the ecological effects resulting from the installation of the diffusers will be minimal.

22.0 Management of Effects

22.1.1 Introduction

The assessment of effects of the WNP proposal on the freshwater and wetland ecological values has been assessed and detailed in the sections above. We have outlined the effects management for each component of WNP, but we note that the effects management is realised for the project as a whole and integrated accordingly.

In this section we collect and summarise all of the effects management for the project, and in the following section (section 23) we outline the additional positive enhancements proposed for WNP.

22.1.2 Approach and assumptions

The management of effects for the site is conceived as a wholly integrated ‘package’ that encompasses all aspects of mitigation and offset proposed for landscape and ecological enhancements (see 23.2 below). Importantly, it is conceived in a manner so that the ‘whole’ is vastly improved from just the ‘sum of its respective components’.

In our approach, we have not matched equivalent ecosystems (i.e. stream classifications) at specific locations with effects, loss and gain. Rather we have focused on achieving the overall integrated outcome. Importantly, we note that we have used the SEV and BOAM as a means of informing the integrated mitigation and offset but it is not used in itself to drive the outcome.

22.1.3 Stream reclamation and diversions

22.1.4 Reclamations

The impact on some watercourses within the footprint of works is unavoidable. The quantum of stream loss resulting from WNP at Willows Farm and at Waihi is summarised in Table 49. Across the footprints of works for WNP there is an overall expected loss of some 4,122 m of low to high value stream loss (Table 50) as well as some 9 m^2 of warm spring. This is to be offset with the creation of 13,753m of stream diversion channels and stream restoration. With the exception of the warm spring, the offset has been informed by an Ecological Compensation Ratio (ECR) and the outcome equates to an approximate 3:1 offset ratio (gain:loss).

Application of the effects management hierarchy means that:

- There shall be no net loss of freshwater ecological function.
- Permanent loss of some 16% of extent (length) of streams.
- A combination of ecologically functioning diversion channels and existing stream channel restoration are to be undertaken as offset for the permanent and temporary loss of stream habitat.

We consider that in considering the shortfall of 16% of loss of extent of watercourse, a further equivalent length of 644 m of stream length is sufficient and appropriate compensation for loss of extent. One benefit of the additional planting is that it can all be accommodated on land owned by OGNZL providing a greater degree of certainty. In addition, we consider that the planting can occur in advance of loss of stream extent.

Table 49: *Anticipated impacts (loss) of freshwater habitats resulting from WNP at Willows Farm and Waihi.*

Freshwater Habitat		
Activity	**Length**	**Comments**
Wharekirauponga Underground Mine / Willows Farm		
Stream Loss	**558 m stream length**	This includes all permanent and intermittent watercourse of Tributary 2 to be reclaimed for the rock stack. Tributary 2 will be reinstated at an enhanced condition following completion of WUG mine activities and removal of the WRS.
Warm spring loss	**7 m**	Includes a warm spring pool of some 9 m^2.
Waihi		
Stream Loss or diversion	**3,554 m stream length**	This includes all watercourses across all works footprints. This is a total length of loss and includes those sections of stream that are to be diverted.
TOTAL	**4,119 m**	4,112 m excluding warm spring

22.1.5 Loss of extent of watercourse

In total, a 4,112 m length of watercourses will be reclaimed by the WNP project, increased to 4,119 m when the warm spring is included (Table 50). A total of at least 3,469 m of watercourse will be created (noting there is no diversion creation for the warm spring). Accordingly, the NPS-FM requirement to avoid loss of extent of watercourses is unfulfilled, with a shortfall of 644 m (16% of loss). This shortfall will be addressed through the planting of an additional length of 644 m of stream within the Mataura and Ohinemuri River catchments. We consider that the planned diversions and the additional enhancement of existing stream length is sufficient to fulfil the requirement to avoid loss of stream extent.

We emphasise that the proposed additional stream enhancement is not included in the enhancement of streams for loss of aquatic ecological values, and in cases the requirement of additionality (i.e. is additional to) is satisfied.

The total length of the reclamations and diversions have been compiled as one as a 'whole of project' assessment. However, for the most part, the created diversions occur at or near to the locations of stream reclamation. Where that has not been feasible, notably the warm spring and the headwater gully at the GOP, the loss extent has been incorporated into the all-project diversions' calculation.

Table 50: *Anticipated loss of extent of watercourses resulting from WNP at Willows Farm and Waihi. Watercourse lengths in metres (m).*

Location	Extent of Loss (metre length)	Watercourse classification	Extent of Diversion (metre length)	Diversion classification
Wharekirauponga Stream catchment	Nil	n/a	n/a	n/a
Warm spring	7	Permanent	nil	n/a
Waiharakeke Stream catchment	Nil	n/a	n/a	n/a
Tributary 2, Mataura Stream catchment	558	Permanent / Intermittent	n/a	n/a
Service Trench	Nil	n/a	n/a	n/a
GOP	47	Intermittent	n/a	Intermittent Incorporated into full extent of diversions
TSF3	2,118	Permanent / Intermittent	2,503	Permanent and Intermittent
NRS	1,389	Permanent and Intermittent	695	Permanent and Intermittent
Total	**4,119**		**3,469**	

22.1.6 Aquatic fauna salvage

It is necessary to reduce the potential mortality of native aquatic fauna species during construction through their removal from any areas of stream works. The objective of salvage is to avoid mortality and to maintain the population of native fauna of streams by capturing and relocating them to suitable habitat up or downstream within the same catchment.

We recommend the following:

- An Aquatic Fauna Salvage and Relocation Plan should be prepared and signed off prior to any streamworks. The Plan should include (but not be limited to):
    - The methodology for baseline surveys for fish, kōura and freshwater mussels in the watercourses.

- The methodology for the placement of fish exclusion barriers at the upstream and downstream extent of the streamworks site so migration back into the streamworks site is not possible.
  - Credentials and experience of who will implement the plan.
  - Fish trapping and electrofishing methodology.
  - Kōura trapping methodology.
  - Mussel search methodology
  - Fauna transportation methodology.
  - Location and description of the relocation site.
- Fish, kōura and freshwater mussels should be salvaged from all watercourses containing water at the time of streamworks.
- Peak fish migration occurs between September and February and streamworks should be avoided during this time if practicable.

22.1.7 Fish passage

A number of migratory fish species are present within the footprint of works including swimming and climbing species. It is necessary to maintain fish passage through culverts to upstream and downstream habitats. The following remediation is recommended:

- Fish passage should be maintained through all culverts with viable upstream habitat.
- The type of fish passage (i.e. climbing or swimming species) required for each permanent culvert should be assessed by a freshwater ecologist. At a minimum all culverts should allow for the movement of climbing species if suitable habitat is present.
- Fish passage to be designed based on NZTA guidance and New Zealand Fish Passage Guidelines (NIWA 2018).
- New culverts are to be designed to incorporate fish passage, where upstream habitat is identified.
- In culverts with steeper gradients fish passage devices such as baffles may need to be considered.
- Consideration should be given to restricting the potential passage of pest fish species if they have been recorded within the stream reach.
- Temporary culverts shall maintain fish passage through them, allowing swimming fish species and other aquatic invertebrates to move through the culvert up and downstream, if appropriate.
- The exclusion of trout from the upper reaches or non-preferable tributary streams will provide benefit for native fish and fauna (e.g., Stream TB1).

22.1.8 Trout fishery

The Ohinemuri River is classified as a significant trout fishery, and there are important trout spawning tributary streams (including the Mataura Stream) as well as streams providing habitat for juvenile trout populations (including the Ruahorehore Stream). We recommend that passage and habitat (including spawning gravels where appropriate) for trout be included in the design of the lower reaches of diversions planned for Ruahorehore Stream.

Passage for trout to the upper reaches of the Ruahorehore Stream diversions is less likely to be achievable and less desirable, thus providing more habitat for the native fish fauna.

22.1.9 Stream diversion and management

Proposed stream diversions across the project must meet ecological objectives and have good ecological functionality, especially if they are considered as part of an offset. The design of diversions will follow a hierarchy of avoidance of effects as much as practicable, and design to minimise effects. The following is recommended for stream diversions:

- Stream diversions are to convey clean surface water (i.e. uncontaminated by construction or operational activities).
- The design of the diversion channels should meet ecological objectives through the creation of a range of stable microhabitats for fish and invertebrates, including the creation of stable pool, run and shallow riffle habitats and the inclusion of gravel and cobble habitat, that at least reach a level of stream function to that predicted through the offset (SEV) calculations.
- The substrate of the diversion channels should optimise conditions for trout spawning (including spawning gravels) and suitable habitat for juvenile trout.
- Riparian vegetation should extend to at least 10 m either side (on OGNZL owned land or with other landowner approval) of the channel and must include low-growing species with overhanging cover.
- Where possible, diversions should be constructed prior to the reclamation of the original channel.

Where a diversion is required but it is not possible to replicate the habitat value (such as the upper reaches of the Ruahorehore Stream Tributary diversion channel) or where construction is taking place, then a clean water cut off drain should be created. This clean water cut off drain is not considered (and therefore not included) to be part of any offset for stream impacts but retains hydrological connectivity to the upper catchment.

Design principles for the design of the stream diversions are shown in Appendix 4, examples of cross-sections of the indicative diversion channels are provided in Appendix 11, and a Draft Stream Diversion and Development Plan is provided in Appendix 14.

22.1.10 Bulk earthworks and sediment generation

Sediment entering waterways can have significant impacts on the flora and fauna living within watercourses. This includes:

- Changes to water clarity that affects the ability for fish to feed and follow visual cues.

- Decrease in water clarity effects light penetration and potential plant and algal growth.
- Settled sediment smothering the bed habitat thus reducing habitat for macroinvertebrates and periphyton.

To address these effects, a range of erosion and sediment control measures must be implemented to minimise the quantum of sediment entering the receiving environment.

These recommendations include the following:

- Sediment and erosion control should reflect best practice and as a minimum the design criteria for all erosion and sediment control measures will be based on WRC TR 2009/02.
- Open area limits will be in place.
- Construction period monitoring of sediment discharges and the implementation of corrective actions where required.
- The development and construction of the culverts are to be undertaken utilising current best practise to minimise the impacts on water quality and instream disturbance.
- Streamworks should ideally be undertaken offline or should be isolated with water pumped around the area of works.
- Ensure material from vegetation removal does not enter the stream.

22.1.11 Stream offset calculations

As outlined above, we have used the ECR to inform our offset. We note that the underlying principle of 'no net loss' is based upon 'no net loss of area-weight stream function'. The ECR method anticipates a minimum quantum of offset ratio of 1:1 (loss: gain).

For the loss of the warm spring, we have provided a ratio-based compensation based on the aquatic attributes.

22.1.12 Assumptions applied to stream offset calculations

We have set out the assumptions included in SEV predicted calculations in Appendix 8.

For the NRS and TSF3 diversions it will be apparent that the diversions are not in place to measure a predicted outcome. However, we have used the measured SEVs for the current TB1 stream, and the Ruahorehore Stream for the TB1 and TSF3 diversions respectively. We note that the current TB1 watercourse is itself a diversion that has been successfully developed into a well-functioning stream watercourse.

We consider this approach is appropriate as the intention is to provide as similar function to the existing SEV of the current TB1 as possible.

22.1.13 Stream outcomes

For WNP the standard SEV multiplier of 1.5 has been applied in the calculation of the ECR. We also note the following:

- The WNP results in no actual permanent loss of streams. Streams are either replaced within a short timeframe (functional diversions) or returned and rehabilitated at a later date (Mataura Stream tributary 2). Owing to the large time delay for rehabilitation of Tributary 2, the loss of this tributary was treated as permanent loss and included in the ECR calculations.
- The overall condition and health of these final watercourses will be an improvement upon those currently present.
- The residual effect on streams is limited to a timeframe rather than a permanent loss.
- In some circumstances, the stream diversions and stream offset restoration works can be commenced and undertaken *prior* to any stream loss.
- The replacement streams (diversions) contain the same source water and retain the same connectivity with their respective upper catchments (i.e. there is no recreation of streams at different locations).
- OGNZL has a successful track record of successful stream restoration work within the OGNZL owned land and around the Waihi area.
- OGNZL has undertaken extensive stream restoration works, particularly on the Ohinemuri River and Ruahorehore Streams, already improving the ecological function of the watercourses (see section 4 of this report). This has never previously been accounted for in any mitigation (and for clarity these existing restoration works are not being utilised as effects management in this application).
- Specific attention is to be given to the enhancement of instream habitats for kōura (*Paranephrops planifrons*) through the addition of habitat such as (but not limited to) wood, boulders and the creation of deeper pools and areas of slower flow.
- The proposed integrated mitigation across all of the WNP will have ecological benefits which are unable to be measured through the use of the ECR. This includes the restoration of continuous and contiguous lengths of the Ruahorehore Stream and tributaries (tributaries 1-3) of the Mataura Stream, and the restoration of headwater streams that in particular provide a foundation for healthy water quality as it commences to flow downstream.
- The stream mitigation is part of an overall integrated mitigation package, where the mitigation ‘whole’ is much greater than the ‘sum of its component parts’ and includes elements that are not included in any mitigation or offset transactions (e.g., connectivity across the site).

Even though there will be no actual permanent loss of watercourses resulting from WNP, we have provided an offset as if there were permanent residual effects and stream loss.

22.1.14 Quantum of stream offset

The ECR calculated quantum used to inform the overall freshwater effects management is summarised in Table 51 and detailed further in Appendix 9. The project has used the ECR method that delivers more than a straightforward loss:gain ‘no net loss’ and accounts for the loss of ecological function. The ECR method has resulted in ‘100%’ offset for the loss of ecological function and values, with the required riparian planting amounting to an average 3:1 ratio. We acknowledge the timelag in the delivery of the final rehabilitated watercourses (noting that even these benefits from earlier implementation of the offset activities).

The overall WNP project has a shortfall in stream extent, with total diversion length some 16% (or 644 m) shorter than stream loss. An additional 644 m of stream within the Mataura Stream and Ohinemuri River catchment will be rehabilitated to compensate for this shortfall. With stream diversion and additional stream planting there is no loss of stream extent. For the benefit of any doubt, this 644 m is in addition to the ECR calculated offset set out above.

We note that the wider mitigation package will include additional riparian planting and will also have additional ecological benefits which are unable to be measured through such accounting methods. Accordingly, we have given value to these attributes in an overall statement of effects management, and we have not relied on ECR calculations alone.

Thus, we consider that whilst the application of the ECR demonstrates a 'no net loss' of ecological values, the integrated approach with considerable connectivity amongst the stream network and interaction with terrestrial environments provides an overall positive net gain in ecological value.

We emphasise that none of the proposed offset locations are required to be managed or restored as part of any existing or future planned permits, consents or other legal commitments.

Table 51: *Anticipated impacts (residual effects of loss of watercourses) and enhancements (offsets) to freshwater habitats resulting from WNP at Willows Farm and Waihi as calculated by the ECR.*

Freshwater Habitat				
Willows Farm				
Freshwater feature	**Stream Loss/reclamation**	**Proposed offset**	**% offset accounted for**	**Comments**
Tributary 2	**558 m stream length**	Riparian restoration of 1,995 m of stream length of Tributary 1 and Tributary 3.	102%	Includes restoration of Tributary 1 (headwaters) and Tributary 3.
Warm spring	**7 m length or 9 m^2**	Restoration and stock exclusion of at least six spring and gully headwaters (at least 80 m in length in total) within headwaters of Tributary 3.	100%	Includes restoration of selected headwater gullies of Tributary 3.
Waihi				
Stream Loss	**3,554 m stream length**	Stream diversion: 2,765 m Stream riparian restoration: 7,646 m	100%	Includes diversion streams that have ecological functionality. Excludes those with no or little ecological functionality. Riparian restoration along one or both sides of the stream out to 10 m or 20 m in width.

Total	**4,119 m**	**2,765 m** Stream diversion **9,641 m** Stream Riparian Restoration.	100%	

22.1.15 Warm spring

The warm spring that is likely to be lost is a pool of approximately 4 m^2 pool, that leads to a 5 m long slow flow channel to the main stem of the Wharekirauponga Stream. This amounts to some 9 m^2 of freshwater habitat.

The warm spring feature is located within the conservation estate and is an unusual natural feature in the local area with a very weak geothermal signature and a low ecological value. In terms of the effects management, despite the low ecological value, as no avoidance or remedial action is available, and no other similarly warm springs are known in the area, an out of type (ecological compensation) will be required (Maseyk et al., 2018).

Accordingly, we have focused the proposed compensation on headwater springs and wetlands as offering similar ecological functional and habitat types. Areas that have been identified include heads of gullies where springs and seepages exist and located where the offset forms part of a much greater package of mitigation across the WNP. Locations of the enhancement areas are shown in Figure 35.

We acknowledge that these headwaters, springs and seepages will be cold springs and will not have the same mineral content as the warm spring (noting that the ecological values of the warm spring are low with no notable geothermal/warm water signature), although a likely better faunal potential will exist.

We have provided a ratio-based compensation with a gain: loss of 12:1, amounting to planting and fencing some 80 m of spring and seepage headwater habitat of Tributary 3 (some 0.35 ha of riparian planting). We have provided a sizeable ratio because:

- The warm spring is a singular unusual feature with no connectivity with other known warm-water features within the Coromandel Forest Park.
- The fauna and flora of the warm spring do not reflect the typical biodiversity of a geothermal habitat.
- The ecological values represented by the warm spring are not unique and have been assessed as Low.
- The ecological compensation does not include or replicate the conditions or enhancement of the mineral character of the warm spring; rather it provides protection and enhancement of a series of headwater springs and seepages of the Mataura Stream with greater ecological enhancement value.
- The offset is some distance away from the warm spring feature and the headwaters of Tributary 3 drain into different stream catchment to that of the warm spring. There is no effective ECR calculation mechanism (such as the SEV) for springs.
- A replacement of the warm spring as a no net loss (i.e. another warm spring) would only deliver a feature of low ecological value; the proposed compensation will deliver greater ecological benefits.

We consider that the compensation is as close a match available for loss : gain, being the surface expression of groundwater (i.e. springs and seepages). We emphasise that this form of compensation is provided for by the NPSFM (Appendix 7).

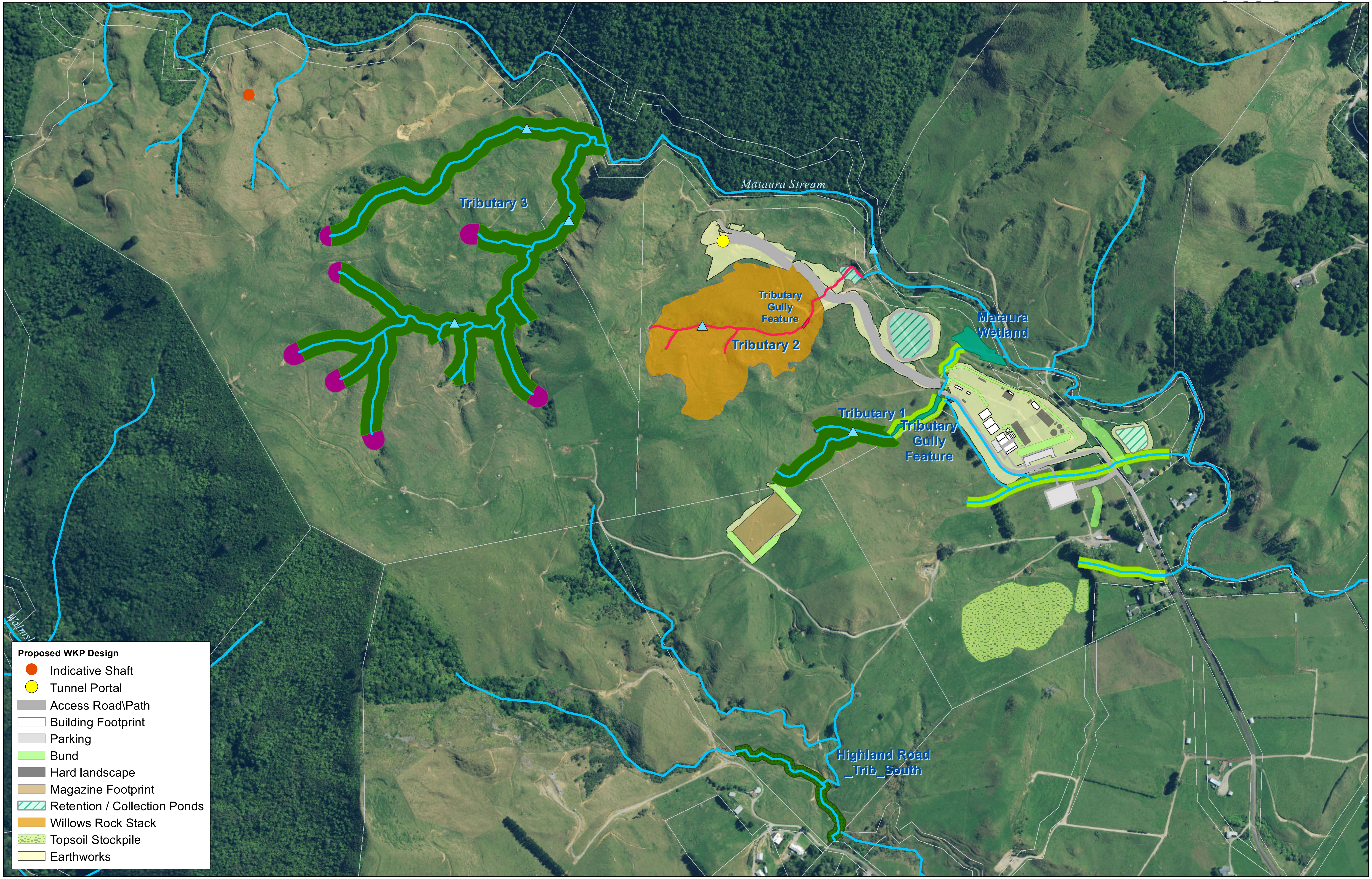
22.1.16 Location of stream offsets

The locations of the stream offsets are shown in Figure 35, Figure 36 and Figure 37. Except for the warm spring compensation (see above), as much as possible the stream offsets have been established at or close by to the stream losses, and the stream diversions occur at the same locations with diversion of the same stream source water. Thus, the Willows Farm site offsets occur within the Mataura Stream catchment, while the diversions and offsets within the Waihi component of WNP predominantly occur within the respective catchments, as a contribution along the Ruahorehore Stream or as a small portion within the Mataura Stream Catchment.,

As outlined above, for the ecological compensation for the loss of the warm spring, these have been located in the headwaters of a tributary of the Mataura Stream (Tributary 3).

A Draft Stream Enhancement Riparian Planting Plan is provided in Appendix 15.

File Ref: BM210482_ECO_05_A3L_FreshwaterOffset_R2.mxd



Boffa Miskell

www.boffamiskell.co.nz

0 200 m

1:6,500 @ A3

Data Sources:
Service Layer Credits: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors, Proposed Infrastructure sourced from Oceana Gold

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Freshwater Sampling Site
- Stream Loss
- Existing Stream
- Existing Wetland
- Wetland Loss
- Stream Offset Planting
- Offset Planting for Stream Extent
- Offset planting for Warm Spring
- Enhancement Planting

WAIHI NORTH

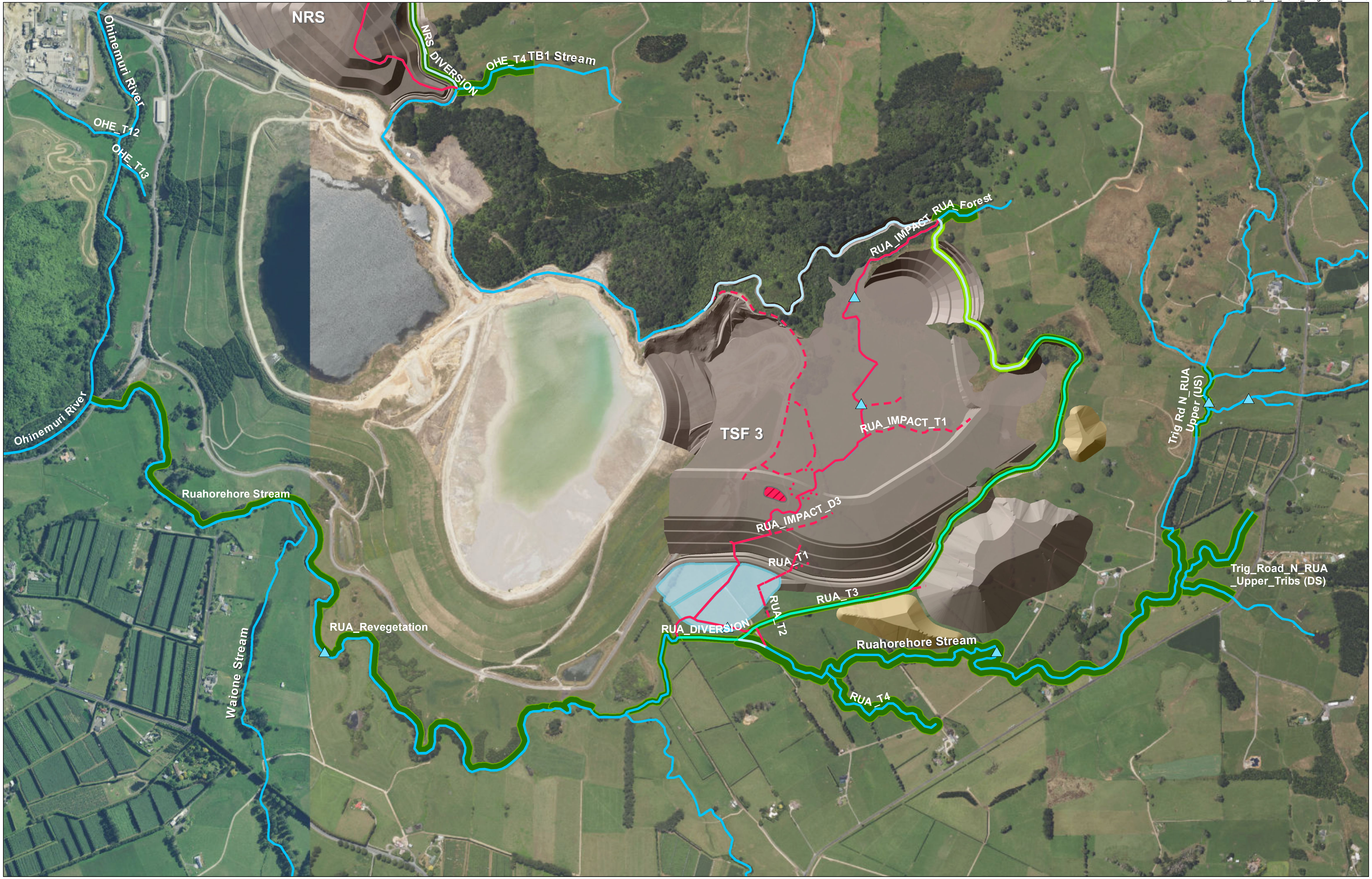
Proposed freshwater offsets and riparian planting areas at Willows Farm

Date: 26 September 2024 | Revision: 2

Plan prepared for Oceana Gold by Boffa Miskell Limited

Project Manager: Ian.Boothroyd@boffamiskell.co.nz | Drawn: HCo | Checked: KMc

Figure 35



Boffa Miskell

www.boffamiskell.co.nz

0 — 400 m
1:10,000 @ A3

Data Sources: Boffa Miskell, OGCL, LINZ

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Freshwater Sampling Site
- Existing Stream
- Cleanwater Diversion Channel (Eco Functioning)
- Cleanwater Diversion Channel
- Stream Loss
- Drain Loss
- Overland Flow Path Loss
- Pond Loss
- Enhancement Planting
- Stream Offset Planting
- Collection Pond

WAIHI NORTH

TSF 3 Freshwater Mitigation and Offset

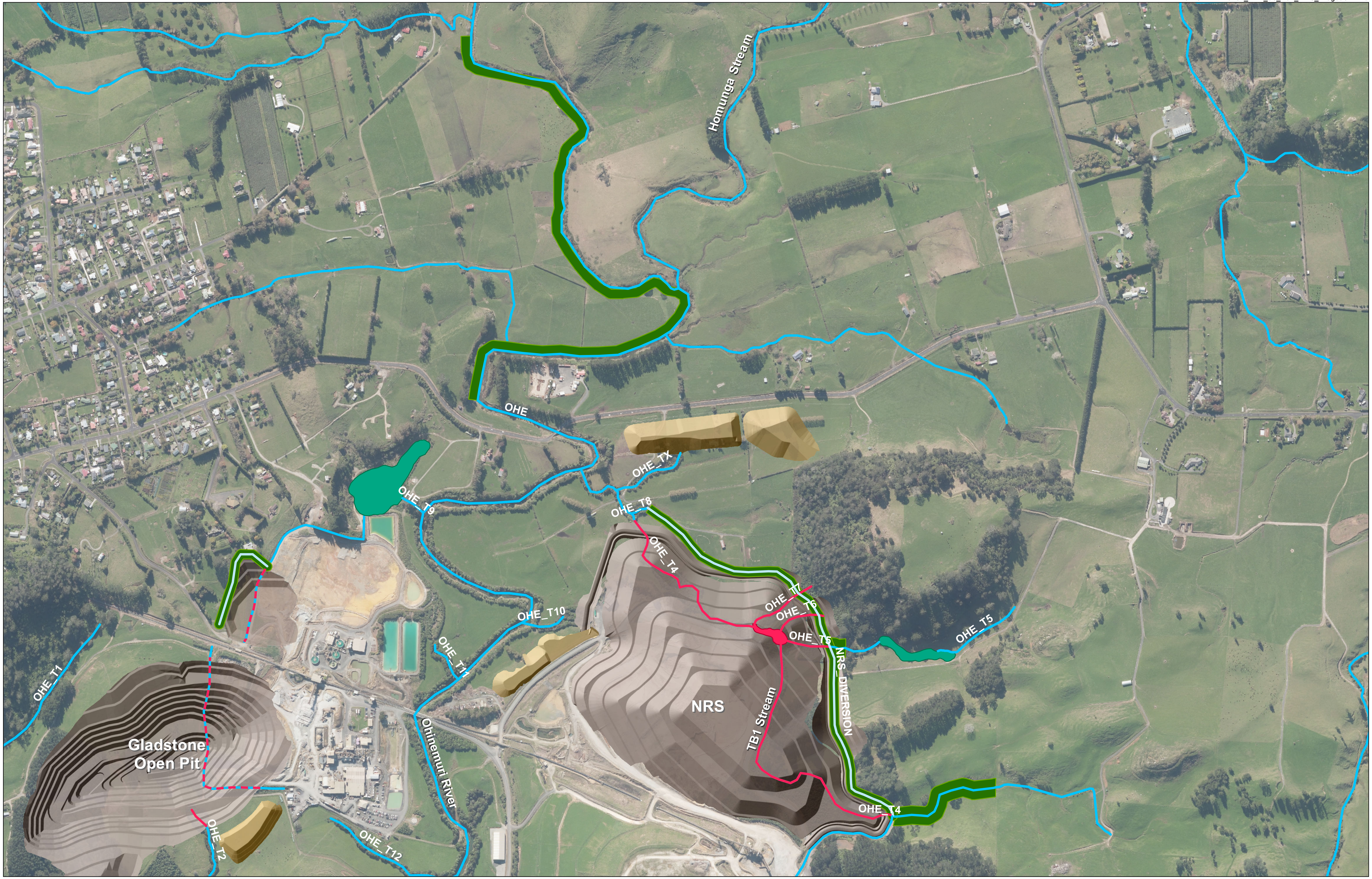
Date: 26 September 2024 | Revision: 1

Plan prepared for Oceana Gold by Boffa Miskell Limited

Project Manager: ian.boothroyd@boffamiskell.co.nz | Drawn: HCo | Checked: KMc

Figure 36

File Ref: BM210482_FRE_08_A3L_NRS_Mitigation.mxd



Boffa Miskell

www.boffamiskell.co.nz

0 — 320 m

1:7,500 @ A3

Data Sources: Boffa Miskell, OGCL, LINZ

Projection: NZGD 2000 New Zealand Transverse Mercator

LEGEND

- Existing Stream
- Cleanwater Diversion Channel
- Permanent Loss
- Drain Loss
- Stream Offset Planting
- Wetland Loss
- Existing Wetland

WAIHI NORTH

Northern Rock Stack Freshwater Mitigation

Date: 17 May 2022 | Revision: 0

Plan prepared for Oceana Gold by Boffa Miskell Limited

Project Manager: ian.boothroyd@boffamiskell.co.nz | Drawn: BMc | Checked: IBo

Figure 37

23.0 Additional positive enhancements

23.1.1 Background

In addition to the mitigation and offset requirements set out above, the WNP project will add considerable additional environmental benefits. These additional actions are designed to integrate and complement the mitigation and offset requirements. Here we summarise these additional enhancements beyond the offsetting set out in Chapter 22 above and comment on the benefits they provide. For the avoidance of doubt the components set out in this chapter do not form part of the offsetting or compensation for loss of ecological values but are in addition to that offset calculation. The components discussed below are not quantified.

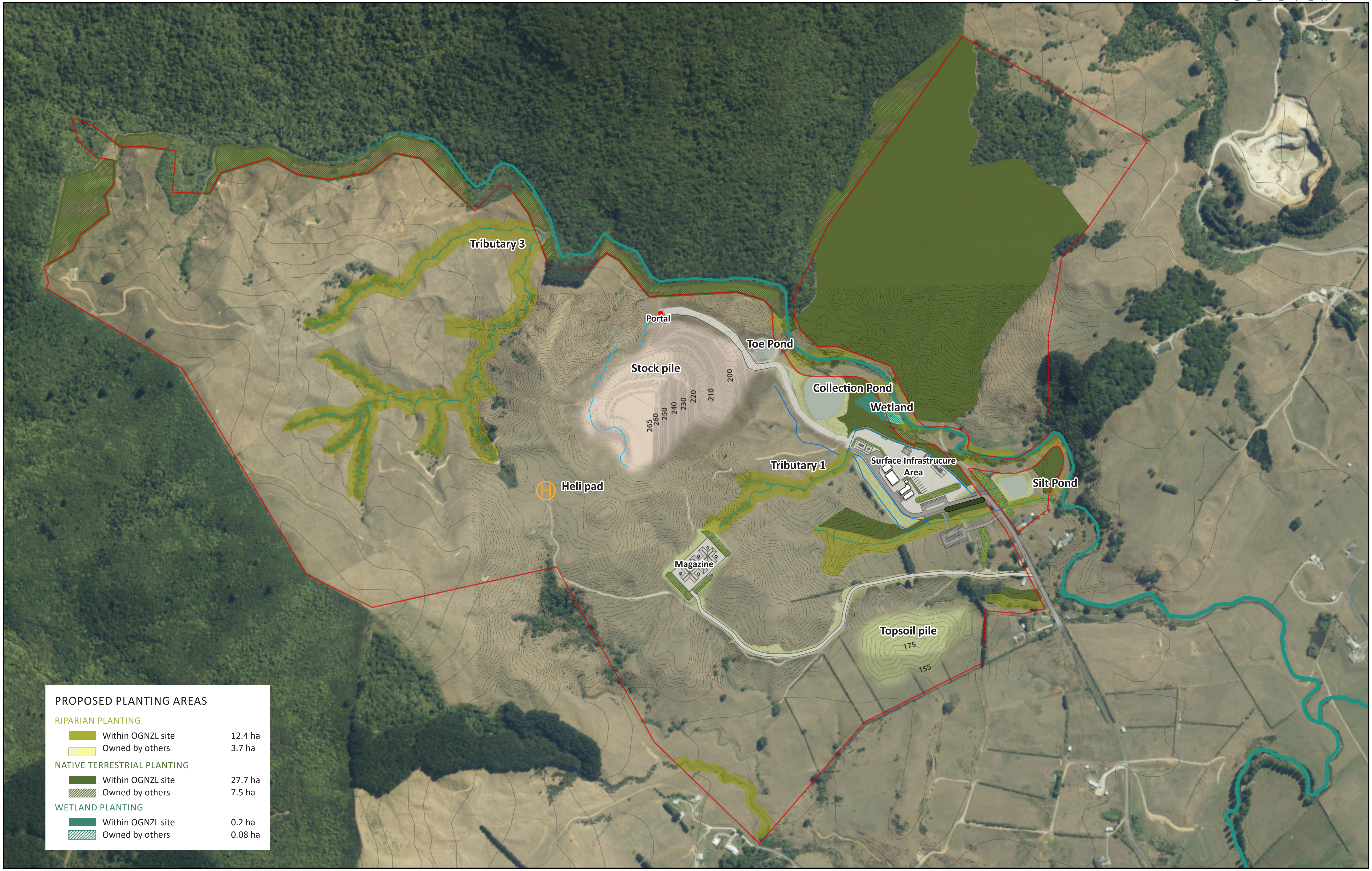
23.1.2 Integrated mitigation

As outlined above, the mitigation for the site is conceived as a wholly integrated mitigation ‘package’ that encompasses all aspects of mitigation and offset proposed for landscape and ecological enhancements. Importantly, it is conceived in a manner so that the ‘whole’ is vastly improved from just the ‘sum of its respective components’.

The integrated mitigation is conceived to provide:

- Ecological and landscape connectivity across and within the Waihi North Project.
- Extensive restoration planting and open areas across the Waihi North Project.
- Extensive riparian planting along the waterways, to complement the riparian enhancements already carried out by OGNZL (and its predecessors).
- Providing recreational opportunities where safe to do so.
- Enhanced habitat for elements of native fauna such as eels, kōura, Cran’s bullies and for wetland birds.
- Greater ecological connectivity across the landscape for both resident and transient fauna.

Our integrated mitigation approach means that ecology is integrated with landscape to provide a more continuous corridor of vegetation which will benefit biodiversity throughout the project area whilst also providing benefit from a landscape and visual perspective. See Figure 37 for all of the proposed planting across the WNP project.



Boffa Miskell

www.boffamiskell.co.nz

NORTH

0 250m

1:7,500 @ A3

LEGEND

- Willows Rd site
- Existing fences
- Existing streams
- Collection steam
- Culverts
- Proposed shelter belt
- Hydroseeded grass
- Bund

WAIHI NORTH

Proposed Integrated Mitigation - WUG Surface Facilities Area

Date: 18 February 2025 | Revision: 5

Plan prepared for Oceana Gold by Boffa Miskell Limited

Project Manager: rhys.girvan@boffamiskell.co.nz | Drawn: EFa | Checked: RGi

Figure 38

Boffa Miskell
www.boffamiskell.co.nz

NORTH

0 500m

1:15,000 @ A3

LEGEND

- OCG land boundary
- SNA boundary
- Existing streams
- Diversion stream (existing)
- Collection steam
- Proposed access road
- Existing recreational trails
- Screening planting retained during GOP operation
- MTB trail
- Hydro seeded grass

WAIHI NORTH

Proposed Integrated Mitigation - GOP, NRS and TSF3

Date: 25 February 2025 | Revision: 6

Plan prepared for Oceana Gold by Boffa Miskell Limited

Project Manager: rhys.girvan@boffamiskell.co.nz | Drawn: KBo | Checked: RGi

Figure 39

23.1.3 Pest and weed management

A pest and weed management plan will need to be developed and implemented for the proposed planting.

23.1.4 Mataura wetland enhancement

In addition, the Mataura wetland will be enhanced through additional planting, managed natural regrowth from existing seed banks, and weed and pest management. This area will be fenced for stock exclusion and subject to pest and weed management. We anticipate that the vegetation will include plants such as raupō, cabbage trees and harakeke reflecting a river flat ecosystem. Swamp maire will be planted and encouraged if the seed source does not deliver the natural rehabilitation.

23.1.5 Reinstatement of Tributary 2

The loss of Tributary 2 is temporary, but the effects management and stream offset calculations set out above has assumed a permanent loss of the watercourse. However, we note that the rock stack is expected to have a 10-year lifespan and following that there will be a period of rehabilitation of Tributary 2. The rehabilitation of the tributary will result in an improved and enhanced catchment compared to that at present, i.e. the tributary will also meet its potential ecological value as assessed through an appropriate ecological offset model. This rehabilitation occurs beyond the offset provided for an assumed permanent loss of the tributary. Combined, the proposed offset and the proposed rehabilitation of Tributary 2 will result in a net gain in freshwater ecological benefit for the Willows Road Farm component of the project.

23.1.6 Landscape planting

A landscape planting plan has been prepared for the project that is inclusive of the mitigation and offset area detailed above but extends planting across the broader landscape. The ecology mitigation and offset planting described above is a separate component but necessarily a key component of the proposed landscape plan. For the most part the same vegetation types are proposed that extends the ecological benefit beyond the calculated offset laid out above. These areas will be fenced for stock exclusion where appropriate and subject to pest and weed management.

23.1.7 Tailings lakes enhancement

The existing and planned (TSF3) tailings lakes form notable features within the OGNZL land holdings, and across the broader landscape. The tailings lakes are large, shallow and as they are elevated receive little runoff from the surrounding land. This means that the water quality can reach high levels of clarity and quality. Even without extensive ecological management, these lakes are self-developing as ecological features. Wildfowl are temporary visitors to the lakes, and reed beds are forming naturally along some of the margins. Active management of the lakes will provide further ecological enhancements. We estimate that enhancement of the tailing lakes will provide 7,485 m of littoral margin length (cf. 1.5 ha[44]), and an open water area of some 88 ha.

23.1.8 Specific enhancements for tuna (eel) habitat

We have given some thought to the potential to further improve habitat conditions for freshwater tuna (shortfin and longfin eels). These enhancements include actions already provided for, but special consideration can be given to the following:

- Riparian planting along the margins of the Ohinemuri River and tributaries. Riparian vegetation has well known benefits for freshwater environments providing bank stability (reducing erosion), shade, provision of logs and leaves to watercourses, and additional source of food as terrestrial insects fall into the water.
- Potential redoubts or backwater refuge areas along streams. These can be shallow holes in the stream bed or cut outs of banks to create shallow backwaters along the Ohinemuri River and/or tributaries. Erosion control features would need to be applied to ensure further erosion did not take place. These areas can provide refuge for eels during high water flows and additional habitat for feeding.
- Extend or create potential open water and channels into and within the littoral wetland and seepage areas along the Ohinemuri River and tributaries. Channels connected to the main watercourses provide access for eels into wetland areas.
- Retrofit any perched culverts along tributaries with fish passage solutions such as ramp or mussel spat ropes. No survey of perched culverts or other barriers has been undertaken within the Ohinemuri River catchment. The NPSFM requires that Councils provide for meeting the objectives of fish passage.
- Opportunity for a fish ladder (for eels and other climbing fish) over the heritage weir downstream on the Ohinemuri River. Although elvers undoubtedly surmount the weir, the provision of a fish ladder for elvers and other climbing fish (e.g., banded kokopu) will aid that passage. Preferable to make it unfavourable for the upstream passage of trout.

The main locations for these activities would be in the Ohinemuri River catchment including the Ruahorehore Stream, Mataura Stream and the Mangatoetoe Stream.

23.1.9 Embedding mitigation

As a final comment we note that the proposed effects management and particularly the mitigation and offsets are approached as fully embedded in the project outcomes. This means that the extent of offset accounts for all stream reclamations up to the point where the gain is equal to the reclamation (i.e. at no net loss). Any offset actions beyond that point of offset is a contribution to ‘net gain’, and is not counted in the offset. Accordingly, should further offset for any future or unaccounted for stream loss occur, a component of offset can be consumed from the net gain up to the point where the loss = gain and no further net gain is available. This averts any arguments of ‘double dipping’ and ‘additionality’ within the proposed development.

[44] Assuming an average of 2 m width of vegetated littoral zone within each lake.

24.0 Conclusion

The WNP comprises several elements occurring at Willows Farm and at the Oceana Gold Waihi operations. Ecological values varied across the proposed WNP locations, ranging from high to very high values in the Wharekirauponga Stream, Waiharakeke Stream and Mataura Stream, and the upper Ruahorehore Stream. In other locations ecological values were lower and varied with land use and other influential factors.

We applied the EIANZ effects management hierarchy to potential effects of the proposed operations. Aquatic features have been avoided where possible (e.g., the Mataura wetland), and native fish, trout, kōura and freshwater mussel will be salvaged and relocated before activities within streams occur.

We consider that with stream diversions plus a component of stream enhancement, the proposed WNP activities do not result in any permanent loss of streams or any loss of extent of watercourses, nor any loss of natural inland wetlands. Streams are either replaced within a short timeframe (ecologically functional diversions) or re-established and rehabilitated at a later date (Mataura Stream Tributary 2). The outcome of the WNP will be an improvement upon those aquatic ecological values than currently present.

Predictions of treated wastewater suggests that the WNP can be implemented using the existing and upgraded WTP, and within the current consent discharge and receiving environment conditions of the Ohinemuri River. The capacity of the current WTP facilities will require upgrading throughout the project's lifetime to cope with the expected volume of water requiring treatment.

No changes to the water quality limits from the discharge from the WTP are required to accommodate the Waihi North Project. There is no evidence that the current discharge from the WTP to the Ohinemuri River has caused any detrimental effects to the ecological values of the Ohinemuri River, and the ecological values have been maintained as anticipated by the criteria as set out in the current consent conditions.

Accordingly, re-consenting the WTP with the same receiving water quality standards will not result in detrimental effects on the ecological values of the Ohinemuri River. Notwithstanding this, we have recommended additional consent conditions for monitoring attributes in the Ohinemuri River to better understand the condition of the river, and for the purpose of better informing the Waikato Regional Council's future implementation of the National Objectives Framework under the National Policy Statement for Freshwater Management.

The overall effects management for the WNP is conceived as a wholly integrated mitigation 'package' that encompasses all aspects of remedy, mitigation and offset proposed for landscape and ecological enhancements. Importantly, it is conceived in a manner so that the 'whole outcome' is vastly improved from just the 'sum of its respective mitigation and offset components'. Such integrative concepts, including connectivity in the landscape and migration pathways, are difficult to capture and quantify within existing biodiversity mitigation concepts and offset models.

Accordingly, the effects of the WNP on aquatic ecological values are low, and the outcome of WNP delivers a no net loss and enhanced positive benefit for aquatic ecological values.

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Appendix 1: Criteria for Determining Significance of Indigenous Biodiversity

Table 1-1 below is reproduced from the Waikato Regional Policy Statement 2016. It lists the criteria for assessing the significant of indigenous vegetation in the Waikato Region and is the basis of the significance assessments of the wetland and terrestrial habitats described in this report.

***Table 1-1**: Criteria for determining significance of indigenous biodiversity (Taken from Waikato Regional Policy Statement 2016).*

Previously assessed site	
1.	*It is indigenous vegetation or habitat for indigenous fauna that is currently, or is recommended to be, set aside by statute or covenant or by the Nature Heritage Fund, or Ngā Whenua Rāhui committees, or the Queen Elizabeth the Second National Trust Board of Directors, specifically for the protection of biodiversity, and meets at least one of criteria 3-11.*
Ecological values	
2.	*In the Coastal Marine Area, it is indigenous vegetation or habitat for indigenous fauna that has reduced in extent or degraded due to historic or present anthropogenic activity to a level where the ecological sustainability of the ecosystem is threatened.*
3.	*It is vegetation or habitat that is currently habitat for indigenous species or associations of indigenous species that are:* • *classed as threatened or at risk, or* • *endemic to the Waikato region, or* • *at the limit of their natural range.*
4.	*It is indigenous vegetation, habitat or ecosystem type that is under-represented (20% or less of its known or likely original extent remaining) in an Ecological District, or Ecological Region, or nationally.*
5.	*It is indigenous vegetation or habitat that is, and prior to human settlement was, nationally uncommon such as geothermal, chenier plain, or karst ecosystems, hydrothermal vents or cold seeps.*
6.	*It is wetland habitat for indigenous plant communities and/or indigenous fauna communities (excluding exotic rush/pasture communities) that has not been created and subsequently maintained for or in connection with:* • *waste treatment;* • *wastewater renovation;* • *hydroelectric power lakes (excluding Lake Taupō);* • *water storage for irrigation; or* • *water supply storage;* *unless in those instances they meet the criteria in Whaley et al. (1995).*
7.	*It is an area of indigenous vegetation or naturally occurring habitat that is large relative to other examples in the Waikato region of similar habitat types, and which contains all or almost*

	all indigenous species typical of that habitat type. Note this criterion is not intended to select the largest example only in the Waikato region of any habitat type.
8.	*It is aquatic habitat (excluding artificial water bodies, except for those created for the maintenance and enhancement of biodiversity or as mitigation as part of a consented activity) that is within a stream, river, lake, groundwater system, wetland, intertidal mudflat or estuary, or any other part of the coastal marine area and their margins, that is critical to the self-sustainability of an indigenous species within a catchment of the Waikato region, or within the coastal marine area. In this context "critical" means essential for a specific component of the life cycle and includes breeding and spawning grounds, juvenile nursery areas, important feeding areas and migratory and dispersal pathways of an indigenous species. This includes areas that maintain connectivity between habitats*
9.	*It is an area of indigenous vegetation or habitat that is a healthy and representative example of its type because:* • *its structure, composition, and ecological processes are largely intact; and* • *if protected from the adverse effects of plant and animal pests and of adjacent land and water use (e.g. stock, discharges, erosion, sediment disturbance), can maintain its ecological sustainability over time.*
10.	*It is an area of indigenous vegetation or habitat that forms part of an ecological sequence, that is either not common in the Waikato region or an ecological district, or is an exceptional, representative example of its type.*
Role in protecting ecologically significant area	
11.	*It is an area of indigenous vegetation or habitat for indigenous species (which habitat is either naturally occurring or has been established as a mitigation measure) that forms, either on its own or in combination with other similar areas, an ecological buffer, linkage or corridor and which is necessary to protect any site identified as significant under criteria 1-10 from external adverse effects.*

Appendix 2: Method and Outcomes of Wetland Delineation

Wetland delineation

The NPS-FM specifies a set of protocols to have regard to in cases where it is uncertain whether a feature meets the definition of a wetland, including specific tools to assess the presence of hydrophytic vegetation and hydric soil indicators (hydrological characteristics are intended as a further assessment tool, however protocols are yet to be developed). A summary of the stepwise “hydrophytic vegetation determination” (wetland evaluation) protocol is set out in Figure 2-1.

Vegetation composition and tolerance of wetland environments is the main component of the step-by-step evaluation, and follows a scoring system that classifies plant species recognised as occurring in or around New Zealand wetland systems according to fidelity to wetland, as follows:

- obligate wetland (OBL: occurs almost always in wetlands),
- facultative wetland (FACW: occurs usually in wetlands),
- facultative (FAC: equally likely in wetlands or non-wetlands),
- facultative upland (FACU: usually in non-wetlands), or
- obligate upland (UPL: almost always in non-wetlands).

These classifications are assigned a numeric “wetland indicator status rating”, allowing calculations of overall wetland species dominance, as well as a “Prevalence Index” score, based on canopy percentage cover estimates of individual species.

The plants used in the classification comprise exotic as well as native species, and include common pasture grasses (e.g., Yorkshire fog, Mercer grass, tall fescue, creeping bent) and pasture weeds such as creeping buttercup, soft rush, birds-foot trefoil etc. Hence, it is to be expected that areas of low-lying, seasonally wet grazing land will score as wetlands using the protocol outlined above.

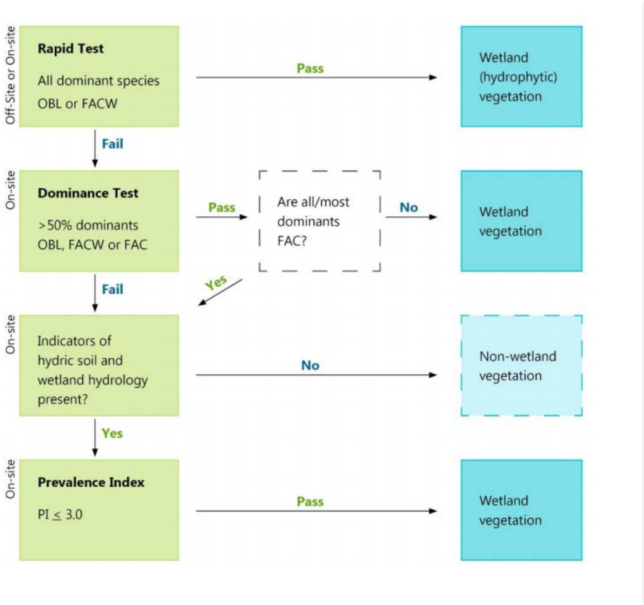

Figure 2-1. *Wetland delineation hierarchy (from MFE 2020).*

Mataura wetland

The wetland is well defined by a transitional "damp area" where there is an obvious visual ecotone occurring, and an inner functional wetland, where the soil profiles reveal a persistently high water table, along with the presence of wet tolerant grasses and rushes.

Evidence of historic wetlands within this area were observed with the presence of two mature swamp maire (*Syzygium maire*), a once common wetland tree, now relict with a threatened status raised to Nationally Critical in 2017, following the arrival of myrtle rust in NZ. In addition, many populations now qualify as "Living Dead" as they persist as remnants within partially drained farmland, such as at Waihi North. Although functionally these specimens are extinct, if fenced this wetland may provide opportunity for this species to recover over time.

With the exception of Transect One, the prevalence index scores indicate a definite zone of transition between the edge of the wetland (Plot 1 and Plot 4 / 5) and the centre plot (Plot 2 / 3) (Table 1), validating our visual assessment of the wetland boundary. Transect One revealed a transitional wetland zone, where the defined wetland was separated with raised areas of pasture (Plot 2 and Plot 3). Transect Three was bordered by a defined watercourse with riparian edge which is validated by Plot 1, surveyed on the edge of the watercourse.

<u>Transect one: Prevalence index scores</u>

T1P1	**T1P2**	**T1P3**	**T1P4**	**T1P5**
2.86	3.23	2.88	3.21	2.75
				
				

<u>Transect two: Prevalence index scores</u>

T2P1	**T2P2**	**T2P3**	**T2P4**	**T2P5**
3.07	2.75	1.83	2.94	3.26
				
				

Transect three: Prevalence index scores

T3P1	**T3P2**	**T3P3**	**T3P4**
1.92	2.86	2.90	3.1
			
Soil profile was not collected at P1 due to high water table. Soil profile was taken on the other side of the watercourse 			

We consider that the Mataura wetland forms a natural wetland on the lower Mataura Stream Terrace. The overall condition of the wetland features is poor, with heavy pugging and a predominance of exotic vegetation.

The wetland appears to be fed by springs and a defined channel forms at the lower end of the delineation, where the wetland is likely to be influenced by a higher water table and possible floodplain from Mataura Stream. In addition, the wetland has been pugged and widened by stock over time.

Northern Rock Stack – TB1 constructed silt pond wetland (October 2020)

	

Appendix 3: Methods for Assessment of Stream Freshwater Ecology

Field Methods

There was variability in the field methods employed across different areas of the Waihi North Project. The three areas of 'Wharekirauponga', 'Willows Farm' and 'Waihi' all contain different freshwater environments.

Wharekirauponga Stream and Tributaries

General stream habitat information such as water depth, stream width, stream substrate composition, riparian characteristics and were recorded based on a modified Department of Conservation Stream habitat assessment – field sheet.

Water quality was recorded utilising a handheld meter (YSI multi-parameter water quality meter) and will measure dissolved oxygen, pH, conductivity and temperature. The readings were be taken at the beginning of the survey, at the downstream extent of the survey reach.

Periphyton communities were assessed for their cover and community cover using the methodology outlined in Gray (2013a). This method involves visual assessment of the periphyton growth on five rocks (i.e. cobbles) at each of three transects across the watercourse (i.e. n = 15). Periphyton community assemblages will be assessed using the methodology outlined in Gray (2013b). This method involves removing the periphyton community off streambed rocks (i.e. cobbles) and preserving it for later analysis in a laboratory. Known area surface sample method was undertaken. Gray (2013b) stipulates the collection of three pooled samples (each from five rocks) collected from each sample site; six pooled samples were collected.

There are two variations on this method; whole stone surface sample or known area surface sample. The final method will be decided on site depending on the size and availability of rocks within the survey reach. as this aligns with the programme undertaken on the Ohinemuri River as part of the ongoing OceanaGold Waihi freshwater monitoring.

Macroinvertebrate communities were assessed through the collection of replicate, quantitative samples following Protocol C3 as described in Stark et al (2001). Six replicate samples were collected at each site using a surber sampler. Samples were processed using Protocol P3, which is a full count of all species, with a subsampling option (Stark et al 2001).

Fish communities were surveyed by electric fishing, following the methods outlined in Joy et. al. (2013). The method includes using a NIWA Kainga300 backpack mounted fishing machine to stun fish within the survey reach. The stunned fish are collected and held in bins of freshwater on the river bank. All fish area identified, measured and checked for general health before being returned to the watercourse. Reaches of 75m were fished owing to the challenging nature of the sites.

Willows Farm

Fieldwork to assess tributary 1 (the original impact site) and the Mataura Stream was conducted on the 20th and 21st of July 2020. Weather conditions were predominantly fine, with some 16mm of rain on the afternoon of the 20th. There was approximately 55mm of rainfall over the seven days prior to the fieldwork.

Further fieldwork was conducted at two potential water take sites within the Waiharakeke Stream catchment on 26th of August 2020. Weather conditions during site visit were overcast with minimal wind. There was approximately 16mm of rainfall during the 48 hours before conducting the site assessment and just over 40mm of rainfall over the previous seven days.

Additional fieldwork was conducted at tributary 2 (second impact site) on 21st of January 2021. Weather conditions during the site visit were overcast with minimal wind. There was approximately 9mm of rainfall over the previous seven days.

As part of the wider assessment of stream values, riparian values were assessed by walking over the sites and recording the native and exotic flora and their evident functional services. No quantitative methods were considered necessary to describe the riparian habitats present as they were small and non-complex habitats. Aquatic ecological values were assessed over representative reaches of the waterways.

Habitat values were assessed at tributary 1 and 2, and the Mataura Stream following the rapid habitat quality assessment described in Clapcott (2015) and Harding et al. (2009). Spot water quality measurements (dissolved oxygen, temperature, pH, conductivity) were taken using a calibrated YSI ProPlus multiparameter meter within the Tributary 2 (impact site) and main stem of Mataura Stream. Composite sediment samples were also collected at the same spot water quality sites. The sediment quality samples were chilled before being sent to Hill Laboratories for analysis of nutrient and heavy metal concentrations.

Sediment cover and grain size were measured at one location within the Mataura Stream using methods based on Clapcott *et al.* (2011). In particular, sediment assessment method 2 (in-stream visual estimate of percentage sediment cover) and method 3 (Wolman pebble count).

A macroinvertebrate sample was collected within all assessed waterways. Samples were collected using a 500-micron kick net following Protocol C1, preserved in ethanol and analysed according to Protocol P1: coded abundance (Stark et al., 2001). Hard-bottom macroinvertebrate indices (MCI-hb and QMCI-hb) were calculated for all samples (Stark & Maxted, 2007) as well as species richness and number of EPT[45] taxa.

The fish surveys within the Tributary 2 and Tributary 3 of Mataura Stream, involved electric fishing using a Kainga EFM300 backpack model. For the tributary 2, electric fishing was carried out at two locations along the tributary reach (two 75 m reaches downstream and upstream of a perched culvert near the access track). Fishing within tributary 3 was undertaken along a 50m reach at each of the SEV survey locations. Any fish species observed during the site walk over were also recorded. All native fish caught at each location were identified, measured, and released. The fishing survey was based on modified methods outlined in Joy et al. (2013), and considered to be adequate to provide an overview of the fish species present within the waterways. For all other Willows Farm sites fish data was taken from the NZFFD.

Stream ecological valuation (SEV) data was collected for the three tributaries of the Mataura Stream (Tributariesv1, 2 and 3) following methods outlined in AC (2011). A single SEV was undertaken on each of tributary 1 and 2, and 3 SEV surveys undertaken on tributary 3. Each SEV is undertaken along a 50 m reach.

Waihi (Northern Rock Stack, Gladstone, TSF3)

A desktop assessment of relevant information from the proposed work areas was undertaken. Most of the information was drawn from the monitoring reports generated by OGNZL for the site, those reports being required under existing conditions of consent. Additional information has been derived from searches of the NZ Freshwater Fish Database and available records held by the Waikato Regional Council.

[45] EPT: Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies), the most sensitive aquatic macroinvertebrate species indicative of good water quality and habitat.

Freshwater surveys were undertaken during autumn and spring 2017 and autumn 2019, at selected sites within the vicinity of the proposed footprint of works at the Northern Rock Stack (NRS), Gladstone Portal laydown and TSF3 areas. Additional surveys of potential mitigation sites on the upper Ruahorehore Stream were undertaken in spring 2024. A preliminary site visit was undertaken within each works area, with watercourses within the area walked, in order to select suitable stream reaches to survey at a later date. Stream reaches were selected based on their suitability to undertake the survey methodology and their representativeness of the wider freshwater environment(s) within the works footprint.

Stream survey assessments followed the Auckland Council Stream Ecological Valuation (SEV) Assessment Methodology as outlined in Auckland Council (2011). Although the SEV methodology is not mandatory, and was developed for the Auckland region, it is increasingly accepted as best practice for informing stream loss and stream mitigation assessments, and our experience is that it is accepted for use in the Waikato region. As part of this assessment fish and invertebrate communities are assessed. Fish communities were surveyed through electric fishing and the use of a NIWA backpack mounted EFM300 electric fishing machine and following standard protocols as outlined in the DOC electrofishing guidelines (DOC 2013). Macroinvertebrates were collected and processed in accordance with national standard protocols C2 and P3 as described in Stark et al (2001). Fish and macroinvertebrate data was not collected for the upper Ruahorehore Stream mitigation sites.

A total of 10 SEV surveys were undertaken; two within the NRS footprint; one within the gladstone open pit footprint; two within the TSF3 footprint; two within the TSF3 downstream receiving environment of the Ruahorehore Stream and three on the upper reaches of the Ruahorehore Stream outside the footprint of works. The surveys were carried out during autumn 2017, autumn 2019 and spring 2024. The SEV sample sites were selected so as to be representative of the types of stream reaches impacted and to be restored.

SEV survey sites within the TSF3 footprint and the Ruahorehore Stream and it's tributaries, with the exception of the headwater forest site, were re-visited in September 2024. Each site was visually assessed to ensure there had been no major changes and the SEV score calculated was still appropriate.

No assessments of water quality were carried out as part of these surveys. As outlined in section 4.2.3 above, the water quality of the Ohinemuri River and the Ruahorehore Stream is collected as part of the monitoring programme undertaken and reported on by OGNZL.

Stream Classification

Streams were inspected and classified using the definitions in the Glossary Section of the Waikato Regional Plan (2012; Online Version), as follows:

River: *A continually or intermittently flowing body of fresh water and includes a stream and modified watercourse; but does not include any artificial watercourse (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal).*

Perennial stream: *A stream that flows all year round assuming average annual rainfall.*

Ephemeral stream: *A stream that flows continuously for at least three months between March and September but does not flow all year.*

Modified watercourse: *An artificial or modified channel that may or may not be on the original watercourse alignment and which has a natural channel at its headwaters.*

__Artificial watercourse__: A watercourse that contains no natural portions from its confluence with a river or stream to its headwaters and includes irrigation canals, water supply races, canals for the supply of water for electricity power generation and farm drainage canals.

__Farm drainage canal__: An artificial watercourse on a farm that contains no natural portions from its confluence with a river or stream to its headwaters and includes a farm drain or a farm canal.

Further habitat assessments were only undertaken on those watercourses that were classified as perennial, or permanent.

Stream Ecological Valuation

The SEV is recommended by Auckland Council for providing an ecological valuation of streams and is increasingly being used outside of Auckland. The SEV uses a set of fourteen qualitative and quantitative variables to assess the integrity of stream ecological functions (Table 3-1). Field work consists of a comprehensive assessment of the in-stream and riparian environment. This includes a fish survey, aquatic macroinvertebrate sampling and cross-sections of the stream to measure width, depth and substrate, as well as using qualitative parameters for reach-scale attributes.

***Table 3-1**: Summary of the 14 ecological functions used to calculate the SEV score.*

Hydraulic functions:	**Biogeochemical functions:**
Processes associated with water storage, movement and transport. • Natural flow regime • Floodplain effectiveness • Connectivity for species migrations • Natural connectivity to groundwater	Relates to the processing of minerals, particulates and water chemistry. • Water temperature control • Dissolved oxygen levels maintained • Organic matter input • In-stream particle retention • Decontamination of pollutants
Habitat provision:	**Biotic functions:**
The types, amount and quality of habitats that the stream reach provides for flora and fauna. • Fish spawning habitat • Habitat for aquatic fauna	The occurrences of diverse populations of native plants and animals that would normally be associated with the stream reach. • Fish fauna intact • Invertebrate fauna intact • Riparian vegetation intact

This data is analysed using a series of formulae in order to produce an SEV score of between 0-1, where a 0 is a stream with no ecological value and 1 is a pristine stream with maximum ecological value. Interpretation of SEV scores is given in Table 4 below.

***Table 3-2**: Interpretation of SEV scores (Adopted from Golder Associates, 2009).*

Score	Category
0 - 0.40	Poor
0.41 – 0.60	Moderate

0.61 – 0.80	Good
0.81+	Excellent

Ecological Compensation Ratio

To calculate the amount of enhancement required to mitigate the impacts of streamworks an environmental compensation ratio (ECR) was calculated.

The environmental compensation ratio utilises the SEV score to calculate a ratio for the minimum area to be restored as mitigation for unavoidable stream loss. The ECR has the underlying principal of 'not net loss' and is based upon 'no net loss of area-weight stream function'. A minimum ratio of compensation of 1:1 is required.

The formula for calculating the ECR is as below:

- *ECR = [(SEVi-P – SEVi-I)/(SEVm-P – SEVm-C)] x 1.5*
- *SEVi-C & SEVi-P are the current and potential SEV values respectively for the site to be impacted.*
- *SEVm-C & SEVm-P are the current and potential SEV values respectively for the site where environmental compensation is to be applied.*
- *SEVi-I is the predicted SEV value of the stream to be impacted, after impact.*
- *1.5 is a multiplier.*

The ECR calculation requires the prediction of a 'potential' and 'impact' SEV scores. The potential scores for impact sites assume that best practise enhancement works have been undertaken. The prediction of the impact scores assume that the proposed streamworks have been undertaken. The generally accepted SEV score for culverts is 0.2. The predicted potential and impact scores do not include biotic functions (invertebrate fauna intact and fish fauna intact) as they are too difficult to predict.

The ECR considers that environmental compensation ratios greater than 1 are valid because of:

- The ecological risk factors associated with the cumulative loss of streams and the steady change in areal distribution of high-quality stream reaches;
- The long time-lag before full benefits of environment compensation (i.e. from riparian planting) accrue to the mitigated sites; and
- The overall difference between the expected and actual success of stream restoration methods.

Biological Indices

Macroinvertebrate Community Index

The Macroinvertebrate Community Index (MCI) score is a biotic index that can be used as an indicator of stream water quality. It relies on the fact that biological communities are a product of their environment – with different organisms having different habitat preferences and pollution tolerances (Stark & Maxed 2007). The MCI involves assigning tolerance values to all taxa based on their tolerance to pollution. Taxa that are characteristic of pristine conditions score higher than taxa that are predominantly found in polluted conditions, where 0.1 is the lowest and 10 is the highest. The final MCI scores are calculated using presence-absence data, with the scores range from 0 to 200, with streams with no taxa present scoring 0 and streams in exceptionally pristine conditions scoring 200 (Stark 1993).

For all streams surveyed the MCI-sb scores were utilised owing to the predominantly sandy/silty stream beds present across all sites.

***Table 3-3**. Interpretation of MCI scores. From Stark and Maxted 2007.*

Quality Class	Descriptions	MCI or MCI-sb Score
Excellent	Clean Water	> 119
Good	Doubtful quality or possible mild pollution	100 – 119
Fair	Probably moderate pollution	80-99
Poor	Probably severe pollution	<80

Other Indices

EPT taxa refers to the number of taxa present from within three generally pollution-sensitive orders of insects; Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). The caddisfly species *Oxyethira* and *Paroxyethira* were excluded from EPT calculations as they are considered to be generally pollution tolerant.

Fish Index of Biotic Integrity, or Fish IBI, is calculated for use within the SEV calculator. The Fish IBI is a measure of how intact the native fish community is within a reach. Utilising a number of metrics including altitude and distance inland, and a large background of data from sites across Waikato, a number of between zero and sixty is calculated (WRC 2007; Table 2). Interpretation of QIBI is provided in Table 3-4.

***Table 3-4**. Attributes and suggested integrity classes for the Waikato QIBI.*

Total QIBI Score	Integrity Class	Attributes
47 - 60	Excellent	Comparable to the best situations without human disturbance; all regionally expected species for the stream position are present. Site is above the 75th percentile of Waikato sites.
36 - 46	Good	Site is above the 50th percentile of Waikato sites but species richness and habitat or migratory access reduced. Shows some signs of stress.
27 - 35	Moderate	Site is above 25th percentile. Species richness is reduced. Habitat and or access is impaired.
6 - 26	Poor	Site is impacted or migratory access almost non-existent.
0	No Fish	Site is grossly impacted or access non-existent.

Appendix 4: Description of Stream Habitats

Wharekirauponga Stream and Tributaries

All survey reaches were located within the wider Parakawai Valley, a catchment of regenerating native forest within the DOC managed Coromandel Forest Park. Freshwater baseline ecological surveys were undertaken in January/February 2019 at four sites within the Wharekirauponga Stream, two on the mainstem and two on tributaries of the Wharekirauponga Stream. A further round of baseline surveys was undertaken at seven sites in February 2024, three of which were surveyed in 2019.

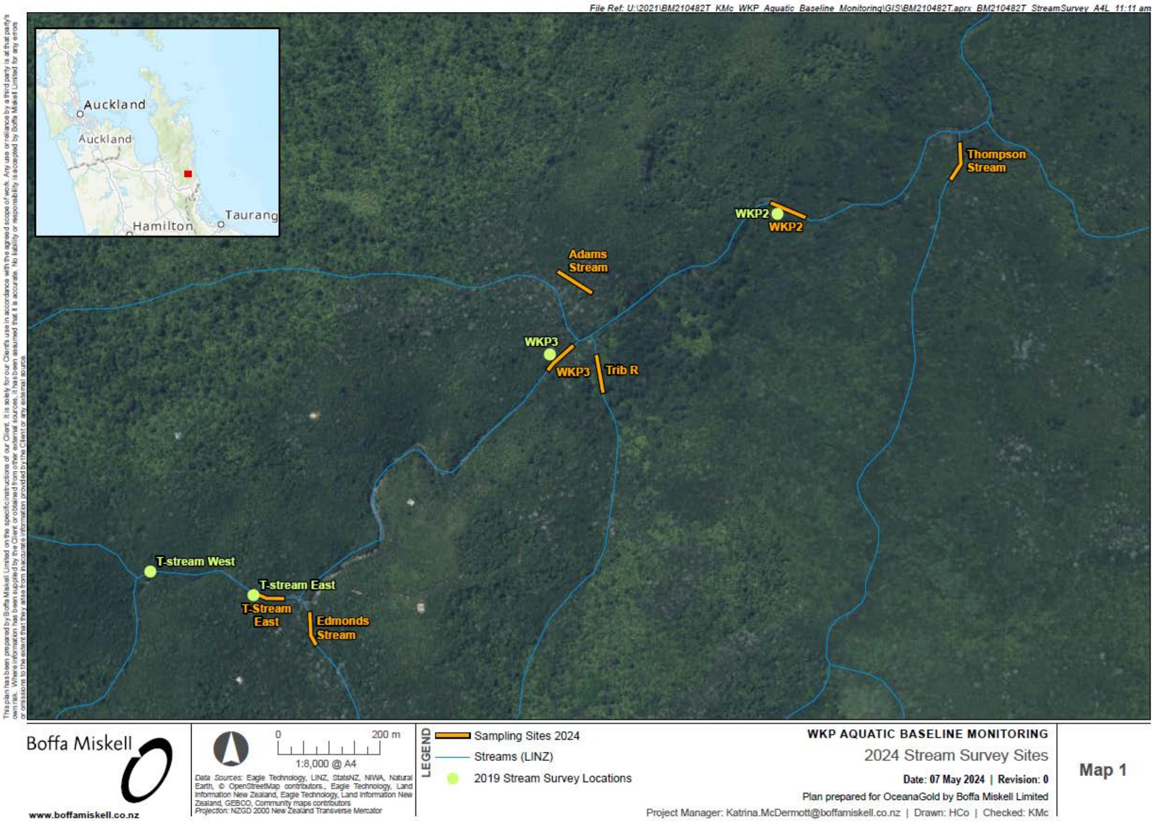

***Figure 4-0**. Wharekirauponga Survey sites, January and February 2019 and February 2024.*

All survey reaches were located within the wider Parakawai Valley, a catchment of regenerating native forest within the DOC managed Coromandel Forest Park. Survey sites were located on a mixture of larger sites on the main Wharekirauponga Stream, and smaller tributary sites.

The surrounding native vegetation and steep stream banks provided partial to full shading to the stream channels, predominantly along the channel edge. Shading was highest at the smaller tributary sites, where the stream banks were steepest, and the average wetted width was the narrowest (see Figure 4-1).

Stream channel substrates were dominated by cobbles and boulders across all sites (see Figure 4-1) Areas of bedrock, of varying size, were observed across all Sites except Thompson Stream, with large areas observed at site Teawaotemutu Stream West. Fine gravels and silt/sand were more abundant at lower catchment sties, particularly along stream margins in areas of lower flow.

Hydrological heterogeneity of the channels was high across all sites, with numerous bedrock platforms and large boulders often narrowing the channel and creating hydrological features such as chutes, cascades and waterfalls. Riffle-pool-run sequences were abundant across all sites. Deep and shallow pools were observed at all sites except Site Trib-R where deep pools were absent.

Woody debris and leaf litter were present, but rare across all sites. Water levels at the time of the both the 2019 and 2024 surveys were low, with summer flows and a long period of dry weather. Water velocity and water volume gauging was undertaken simultaneously by hydrologists from Golder Associates (NZ) Limited during the 2019 survey.

Wharekirauponga Waterfall is located on the Wharekirauponga Stream downstream of Teawaotemutu and Edmonds Stream. The Waterfall is approximately 4 m in height and presents a significant barrier to fish passage.

Figure 4-1(a): *Wharekirauponga survey site Teawaotemutu Stream West **

Figure 4-1(b): *Teawaotemutu Stream East*

Figure 4-1(c): *Edmonds Stream*

Figure 4-1(d): *WKP-3*

Figure 4-1(e): *Adams Stream*

Figure 4-1(f): *Trib-R*

Figure 4-1(g): *WKP-2*

Figure 4-1(h): *Thompson Stream*

Waiharakeke Stream

The two assessment sites were located on tributaries connecting to the main stems of the Waiharakeke Stream (main stem and right branch). Both reaches comprised similar habitat features and are described together. The watercourses flowed at the base of mostly steeply graded gully systems and followed a natural flowpath with no modification observed across the assessed reaches. The hard-bottom stream beds consisted of a range of substrate including gravels, cobbles, boulders and bed rock. Silt and sand made up a small proportion and were found mostly build up behind logs or large rocks near the edge of the stream.

Stream width (wetted width) varied between 0.3 to over 1m, with water depth typically varying from 0.1 to 0.3m. Although again, we note that stream flows were likely to have been high due to the time of year the assessment was conducted. Instream habitat quality and quantity was high, with diverse and abundant habitat types. Habitats included diverse hydraulic components consisting mostly of riffle habitat as well as pools and occasional waterfalls. Undercut banks were present along the assessed reach of the tributary connecting to the main stem while large and small woody debris was common at both assessment sites. Macrophytes were absent from both assessed reaches, although bryophyte was common, particularly at the assessed reach of the tributary connecting to the right branch.

Figure 4-2(a): *Unnamed tributary of the assessed reach of Waiharakeke main stem*

Figure 4-2(b):*Unnamed tributary of the assessed reach of Waiharakeke main stem*

Figure 4-2(c):*Unnamed tributary of the assessed reach of Waiharakeke right branch*

Figure 4-2(d) *Unnamed tributary of the assessed reach of Waiharakeke right branch*

Mataura Stream

The assessed reach of Mataura Stream (adjacent to the proposed works site) followed a natural flowpath at the base of a large gully system with gully sides that varied from steep to flat flood plains (Figure 1). The hard-bottom stream bed predominantly consisted of gravels, cobbles and boulders with occasional areas of silt and sand in less exposed sites where flow velocities were reduced (i.e. stream edges).

Stream width (wetted width) varied between 5 to 8 m, with water depth typically varying between 0.3 m to over 1 m. Although we note that stream flows were likely to have been high due to the time of year the assessment was conducted. Instream habitat quality and quantity was high with diverse hydraulic components consisting mostly of run and riffle habitat as well as varying sized pools. Undercut banks were also common as well as overhanging / encroaching riparian vegetation. There was evidence of occasional recent erosion along both banks with small slips and bank slumping.

Riparian margins had been fenced off on both banks with a buffer zone of approximately 5m. Riparian vegetation consisted mostly of rank pasture and low stature species such as blackberry, pampas, bracken fern, karamu, tutu and wineberry. There were also several large pine trees. Pockets of taller riparian vegetation were present upstream and downstream of the assessed reach. Pasture species were present beyond the riparian margin. There was no macrophytes or algae growing within the assessed reach (we note that this is likely to be minimal anyway due to the time of year the fieldwork was completed). There was evidence of recent flood flows with flattened vegetation within the riparian margins.

Figure 4-3(a)*. Mataura Stream reach flowing adjacent to the proposed works site.*

Figure 4-3(b). *Mataura Stream reach flowing adjacent to the proposed works site.*

Tributary 1

Tributary 1 is located within a relatively steep, incised gully. The streambed is comprised of a mixed of silt/sands, gravels and cobbles, with some unnatural loading of fine sediment observed. Macrophyte species were rare. The channel is incised from flood flows in places and an instream structure is present, affecting flows. Mean water depth was 0.12m, with the deepest point 0.24m.

Instream habitat quality and quantity was considered moderate. The channel is poorly shaded with, with the surrounding riparian zone predominantly short grasses that are grazed.

Tributary 2

The Tributary 2 also arises from springs from two different arms within the upper reaches. At the time of the site visit, a trickle of water was flowing from the southern arm while the northern arm was dry (although a channel was present). The watercourse flowed at the base of a mostly steeply incised gully, with occasional areas of reduced gradient, including immediately upstream of the vehicle crossing. There is an additional side branch that feeds into the main stem. The stream consisted of both hard-bottom and soft-bottom reaches with obvious fine sediment loading in places. Hard-bottom reaches consisted of gravels, cobbles, boulders and bedrock. Several culverts were located along the tributary for stock crossings as well as a vehicle crossing towards the downstream extent of the reach. There was a perched culvert immediately downstream of the vehicle crossing, although this site also consisted of a steep drop off. The perched culvert and steep drop are likely to form a barrier to fish passage upstream.

Stream width (wetted width) varied from less than 0.2 to over 1 m with water depth typically less than 0.2 m, although there were occasional pools within the lower reaches that were greater than 0.5 m deep. Instream habitat quality and quantity was moderate, with diverse habitat types present across the extent of the watercourse. However, there were several reaches where instream habitat was less diverse. Habitats included diverse hydraulic components consisting mostly of riffle and run habitat and to lesser extents pools and occasional waterfalls. Undercut banks were common as well as overhanging / encroaching riparian vegetation and root mats from mostly low stature riparian vegetation. Macrophytes were also present in slower flowing and more open reaches and along the stream edge. Macrophytes included willow weed, *Glyceria* sp. and mercer grass (*Paspalum distichum*).

The watercourse was not fenced off from stock with pugging and bank slumping. There were some reaches that stock were not able to access due to the steepness of the banks. Riparian vegetation consisted largely of grazed pasture (and other low stature vegetation), although there were sections of taller stature native vegetation mostly found on steep banks which were more difficult to access by stock. Vegetation included species such as mahoe, wineberry, kawakawa, tree ferns, karamu, manuka and several fern species. There was a riparian wetland area which was unlikely to be natural. Figure 4-2 show the Tributary 2.

4-4a. *Tributary 2 reach flowing through a section with more intact native riparian margin.*

4-4b. *Tributary 2 reach flowing through a section with minimal riparian vegetation.*

4-4c. *Tributary 2 reach with grazed margins on both sides of the stream.*

4-4d. *The two small branches at the headwaters of the Tributary 2.*

Tributary 3

Tributary 3 is located to the north of the proposed footprint within Willows Farm. The surrounding land is steep and is currently used for pastoral grazing of cattle. The streambed is comprised of a mixture of silt/sands, gravels, cobbles, boulders and bedrock. Instream organic material is abundant, with watercress abundant in places. Green filamentous was also present. Riparian vegetation is limited to a few trees, but it predominantly short and long grasses. Shading of the stream is low, with most of that coming from the steep stream banks. There are areas of active erosion, with channels having loading of unnatural fine sediments in places. Stream channel width is variable from 0.3 – 2.2m.

Northern Rock Stack - TB1 Stream

TB1 Lower Stream

The proposed footprint of the NRS encompasses a significant portion of the stream 'TB1' and its tributaries. Site TB1_lower was located on the main TB1 Stream some 200 meters upstream of the confluence with the Ohinemuri River and was chosen for its representativeness of the TB1 Stream. Site TB1_upper was located upstream on a tributary to the TB1 stream and was selected for its representativeness of the stream habitats within the eastern extent of the NRS footprint.

Site TB1_lower had a reasonably wide (1.7 – 3.4 m) channel with a predominantly silt/sand substrate with the occasional small gravel present. Water flow was slow, with large and deep pools (up to 1.26 m deep) present along the reach and some areas of anoxic sediment. Riparian vegetation had been planted to approximately 10 m either side and fenced off from the surrounding grazed pasture. Native species such as flax, lemonwood, cabbage tree and mapou have been planted, amongst others. The giant umbrella sedge is abundant along the stream edge on both banks, with it extending out to several meters towards the downstream end of the reach. Small areas of active erosion were present along the reach, with bank slumping more apparent at the downstream end of the reach.

Macrophytes were rare along the survey reach, with small areas of *Nitella* sp. present along the survey reach. At the downstream end of the reach the stream channel shallowed and concentrated patches of watercress and water purslane (*Ludwigia palustris)* were present.


Figure 4-5(a)*: TB1 stream lower reach upstream*


Figure 4-5(b)*: TB1 stream lower reach instream*


Figure 4-5(c)*: TB1 stream lower reach instream*


Figure 4-5(d): *TB1 stream lower reach downstream*

TB1 Upper Stream

Site TB1_upper had a narrow stream channel (0.4 – 0.9 m) with channel incision resulting in comparatively high stream banks (0.5 – 1.0 m). The stream channel was predominantly silt/sand, with some small gravel and patches of bedrock also present. Riparian vegetation was limited, with overhanging pasture grass, *Juncus effusus*., fern species and Japanese honeysuckle (*Lonicera japonica*) present. The stream and two metres of the riparian zone are fenced off from stock access. Isolated patches of bank slumping were present along the reach.

Macrophytes were common along the reach with mercer grass (*Paspalum distichum*) present along the majority of the reach, with small patches of watercress and starwort (*Callitriche stagnalis)* also present.

Figure 4-6(a)*: TB1 stream upper reach upstream*

Figure 4-6(b)*: TB1 stream upper reach downstream*

Figure 4-6(c): *TB1 stream upper reach instream*

Figure 4-6(d): *TB1 stream upper reach instream*

Ruahorehore Stream

Seven SEV surveys were undertaken, three were within the TSF3 footprint (sites RUA_Lower RUA_upper and RUA_forest), and four outside of the footprint; RUA_revegetated and RUA_Trig_Road, and TRN_RUA_Upper and TRN_RUA_Up_Trib_US. Sites RUA_upper and RUA_forest are located on tributaries of the Ruahorehore Stream and RUA_Lower on the Ruahorehore Stream. Both site RUA_lower and RUA_upper are located within grazed pastoral flats, with the stream fenced off from stock, and represent the majority of watercourses within the footprint.

Site RUA_forest is located upstream of both sites, within a parcel of fernland-forest. RUA_upper and RUA_forest drain into the Ruahorehore Stream immediately downstream of site RUA_lower, with all sites ultimately draining into the Ohinemuri River. Site RUA_revegetation is located downstream of the footprint, on the Ruahorehore Stream while RUA_Trig_Road is located on a tributary upstream of the footprint. Both sites are fenced off from stock access within pasture. Sites TRN_RUA_Upper and TRN_RUA_Up_Trib_US are located to the west of the proposed TSF3, towards the headwaterse of the Ruahorehore Stream No SEV surveys were undertaken on the vegetated drains.

Site RUA_lower_Revegetated is the most downstream survey site located on the Ruahorehore Stream and is located outside the footprint of works. The true right bank (TRB) of this section of stream has been revegetated by OGNZL and is fenced off from stock. The true left bank (TLB) has no riparian vegetation and is fenced off from stock. The streambanks are over 2 m in height on both banks, with large areas of bank slumping and erosion evident on the TLB. The stream channel has a variable width (1.15 – 3.3 m) and shallow depth ($\bar{x}$ 0.0.2m). The streambed is predominantly comprised of silt/sand with some areas of bedrock and gravels present. Macrophytes were common along the reach, with water pepper (*Persicaria hydropiper*) abundant along stream margins and where deep soft sediment present within the channel. Channel shading was low, with the riparian margins providing almost no overhanging cover.

Site RUA_lower is a reasonably wide (2.2-3.0 m) and deep ($\bar{x}$ 0.67 m) stream with a silt/sand channel. Water flow was moderately swift, with the survey section one large, deep, run section. Macrophytes were abundant within the reach, with large areas of watercress (*Nasturtium officinale*), water pepper (*Persicaria hydropiper*) and Canadian pondweed (*Elodea canadensis*) present along the reach. Smaller patches of the submergent species *Nitella* sp. and blunt pondweed (*Potamogeton ochreatus*) were also present. There was no riparian vegetation present, with the stream surrounded by grazed pasture. Bank slumping was evident along the reach, with areas of pugging from stock also present, particularly on the true left bank.

Site RUA_upper is located within grazed pasture, fenced off from stock with an electric wire along the top of the stream bank. The channel is reasonably narrow (0.17-1.48 m) with high (>1 m), almost vertical stream banks. The channel is predominantly smooth clay and silt/sand, with some smaller gravels present. Water within the reach is exceptionally clear, with a mean depth of 0.28m. Macrophyte species were rare with small patches of watercress and starwort (*Callitriche* sp.) present. However, large areas of bank collapse have resulted in large patches of pasture grass species within the stream channel. Riparian vegetation consists of overgrown pasture grass species with the occasional fern and gorse (*Ulex europaeus*) and other groundcover weed species present.

Site RUA_forest is located within a regenerating forest area, upstream of the two other survey sites. The stream channel is predominantly comprised of large boulders, with a mixture of pools, runs, cascades and waterfalls present. Stream width was variable (0.6-2.32 m) and had an average depth of 0.20 m. No macrophyte species were present along the survey reach and no areas of bank erosion wo0ere observed. Vegetation within the riparian zone is dense with black tree fern (*Cyathea medullaris*) the dominant species, with some remnant mature pine trees present. The understory is predominantly native with species such as gully fern *Pneumatopteris pennigera*), mahoe (*Melicytus ramiflorus*), hangehange (*Geniostoma ligustrifolium*), soft mingimingi (*Leucopogon fasciculatus*) and silver fern (*Cyathea dealbata*) present. African club moss (*Selaginella kraussiana)* is the dominant ground cover, this is an invasive weed species that can prevent the establishment of native seedlings. Bryophyte species abundant along the stream banks.

Site RUA_Trig_Road is located on the Ruahorehore Stream, adjacent to the proposed TSF3 stockpile areas, but outside the footprint of works. The reach is located within grazed farmland and is fenced off from livestock. The stream has a variable width (1.8 – 3.4 m) and is moderately deep ($\bar{x}$ 0.56 m). The streambed was almost entirely comprised of silt/sand with rare small gravels present. Periphyton was abundant. Macrophytes were abundant, particularly along the stream edges including the emerged species willow weed and mercer grass (*Paspalum distichum*) and the submerged species *Elodea canadensis* and *Nitella sp.* Stream shading was low, with riparian vegetation limited to a few specimen exotic trees and pasture grass.

Site TRN_RUA_Upper is located on the Ruahorehore Stream, just downstream of where it flows under Trig Road North, and towards the top of the catchments. The reach is located within grazed farmland and is fenced off from livestock. The stream has a variable width of 1.2-2.6 m, and depths of 0.08-0.52. The streambed was predominantly silt/sand and small gravels, but had the occasional cobbles, boulders and area of bedrock. The streambanks were high in the lower reach (>3m) with areas of slumping and active erosion observed, and abundant areas of overhanging banks. No periphyton was observed and macrophytes were rare with some small areas of watercress present. Stream shading was very low with no effective shading. Riparian vegetation was mostly limited to a few exotic shrubs and pasture grasses within the fenced off riparian margin.

Site TRN_RUA_Up_Trib_US is a tributary that flows into the downstream extent of TRN_RUA_Upper. The reach is located within a grazed paddock and is fenced off from stock. Channel clearance occurs on this reach, with evidence of semi-recent clearance occurring. The stream was narrow with a width range of 0.4-0.77 m. The streamed was predominantly comprised of silt/sand/clay with some gravels. Shading was very low, with small patched provided by overhanging vegetation. The riparian margin was limited to a few exotic shrubs and pasture grasses. Upstream of the SEV reach, a small fork in the tributary has been planted with native species.