Appendix L – Ecological Impact Assessment

ECOLOGICAL IMPACT ASSESSMENT

2025 Ōhaupō Road, Te Awamutu, Waikato

for Te Awamutu Developments Limited

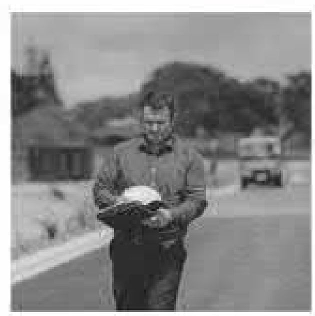
Rev - 25/11/2022

BTW COMPANY

SURVEYING | ENGINEERING | PLANNING & ENVIRONMENT








2025 Ōhaupō Road, Te Awamutu, Waikato

for Te Awamutu Developments Limited

Reviewed

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Rev - 25/11/2022

SUMMARY

Te Awamutu Developments Limited (the client) have proposed a development on 2025 Ōhaupō Road, Te Awamutu, Waikato (Part Lot 1 DP 356454 and Lot 1 DPS 36696), which will require a Private Plan Change Request. BTW Company (BTW) was engaged by the client to undertake an Ecological Impact Assessment (EcIA) for the change in land use for the subdivision and associated earthworks and infrastructure required for the development. The EcIA was required to inform the master design for the subdivision to identify key ecological attributes and values so they could be encompassed as part of the applicant's revegetation and restoration goals for the site.

This EcIA report details the existing ecological values of the site and investigates the potential and actual effects, both adverse and positive of the proposed works on these values. This assessment was based on the Environment Institute of Australia and New Zealand Inc. (EIANZ) EcIA Guidelines (Roper-Lindsay *et al.,* 2018[1]), developed for assessment of terrestrial and freshwater ecosystems in New Zealand.

The existing ecological values can be summarised by the following main points:

- All the watercourses (and wetlands) traversing the site were degraded in terms of ecological health indicators and water quality and all have been modified by channelisation and straightening.
- Although largely fenced to exclude stock, the water courses are devoid of indigenous riparian vegetation and were assessed as having low ecological value.
- The highest ecological valued units on the site are the wetland habitats and the kahikatea forest remanent (identified as a significant natural area [SNA]).
- Other than the wetland and kahikatea remanent, terrestrial vegetation ecological values were either low or very low as the land was dominated by introduced pasture grasses used for agriculture.

In summary, the postive ecological benefits from the project include:

- Restoration and revegetation of the riparian and stream habitats and improvements in water quality and stream health with the change in land use.
- Improved erosion control within the streams and on their margins, through fencing and biodiversity planting.
- Increases in riparian plant diversity and increased wetland extent and representation of guilds, through remediation planting and restoration.

The project does have the potential to cause adverse ecological effect in the Mangapiko Stream and the identified wetland areas. These effects include:

- Potential loss of stream bed habitat and stream length due to culverting associated with internal road access.
- Potential to impede fish passage into and through the culverts.
- Potential for injury and/or mortality of native fauna during construction and bank recontouring.

[1] Roper-Lindsay, J., Fuller S.A., Hooson, S., Sanders, M.D., Ussher, G.T. 2018. Ecological impact assessment. EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd edition.

- Potential for temporary sedimentation from any uncontrolled discharges to the downstream receiving environment during stream works and earthworks.

The following recommendations have been proposed to address any actual or potential adverse effects:

- Preparation of an Erosion and Sediment Control Plan (ESCP) and Stormwater Management Plan (SMP)
- Minimisation and aquatic offsetting for the stream bed and bank loss by preparation and implementation of an Ecological Management Plan (EMP), as part of the resource consent condition process.
- Preparation and implementation of a Fish Management Plan to avoid or minimise the harm to freshwater fish during construction and stream restoration works.
- Enacting the recommendations in the draft Riparian and Waterways Restoration and Enhancement Plan

Implementation of the proposed management plans, and other proposed mitigation measures recommended in this report, will appropriately avoid or minimise any actual and potential adverse effects of the project and help realise the ecological benefits.

The proposed works are not anticipated to have any significant residual adverse effects on the predevelopment baseline condition. The change in land use, improvements in riparian planting, wetland restoration, as well as weed and pest management and erosion control are expected to result in net positive effects on freshwater and terrestrial ecological values in both the Mangapiko and Waipā Catchments.

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FIGURES

1 INTRODUCTION

1.1 Background

BTW Company (BTW) was engaged by Te Awamutu Developments Limited (the client) to undertake an Ecological Impact Assessment (EcIA) to inform the master planning design process for a proposed development located at 2025 Ōhaupō Road, Te Awamutu, Waikato. The development requires a Private Plan Change Request from the Waipā District Council. Figure 1.1 and Figure 1.2 present site location and aerial image overview.

The site is a 25.78 ha (257,800 m²) parcel of land (Part Lot 1 DP 356454 and Lot 1 DPS 36696). Current land use at the site is pastoral agriculture. The proposed development will require watercourse crossing and earthworks adjacent to water courses and wetlands within the site. The Preliminary Subdivision Scheme Plan is presented in Figure 1.3 and Appendix A.

The site is located north of Te Awamutu and South of Hamilton City and is adjacent to State Highway 3. The site is in the Waipā District Council (WDC) territorial area, and the Waikato Regional Council (WRC) Regional Authority. Under the WDC District Plan, the site is zoned as rural, but borders the urban limit boundary (residential zone). Growth cell area T13[2] is located to the southwest of the site (Figure 1.4).

The stimuli for this EcIA is to highlight ecological values, risks, and opportunities to inform and evolve the proposed development design with ecological considerations. As a result, the EcIA is regarded as a living document which is to be updated concurrently should the master design change significantly.

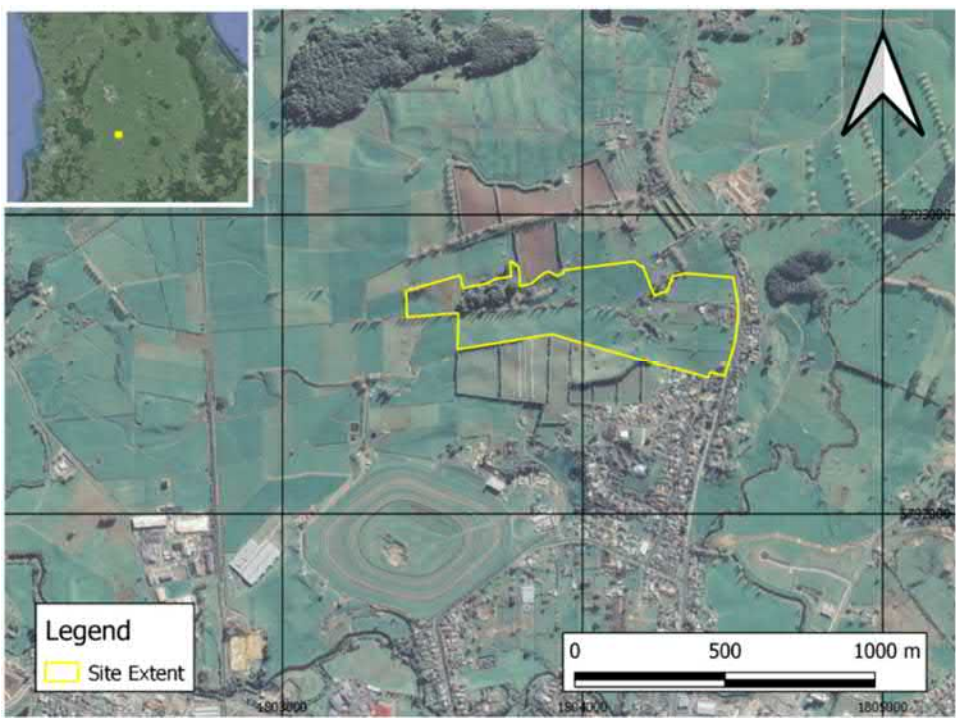

Figure 1.1: Site location.

[2] Identified as T13 (35 ha) in the location of the current Te Awamutu Racecourse. T13 is identified as a potential future residential growth cell if no longer needed for its current purpose.

Figure 1.1 Imagery source: Google Satellite Map Service © 2022 Maxar Technologies. Plotted by BTW.

Figure 1.2: Site overview.

Figure 1.2 Site imagery collected by BTW, surrounding aerial imagery sourced from Google Satellite Map Service © 2022 Maxar Technologies.

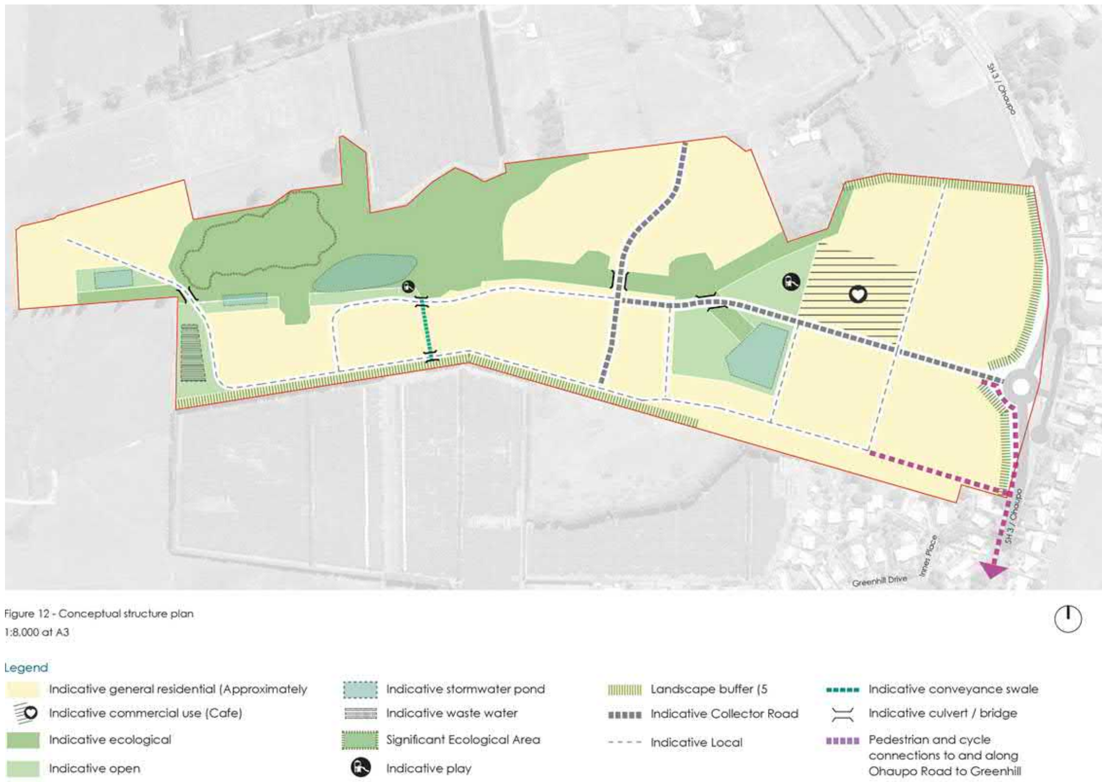

Figure 1.3: Conceptual Structure Plan

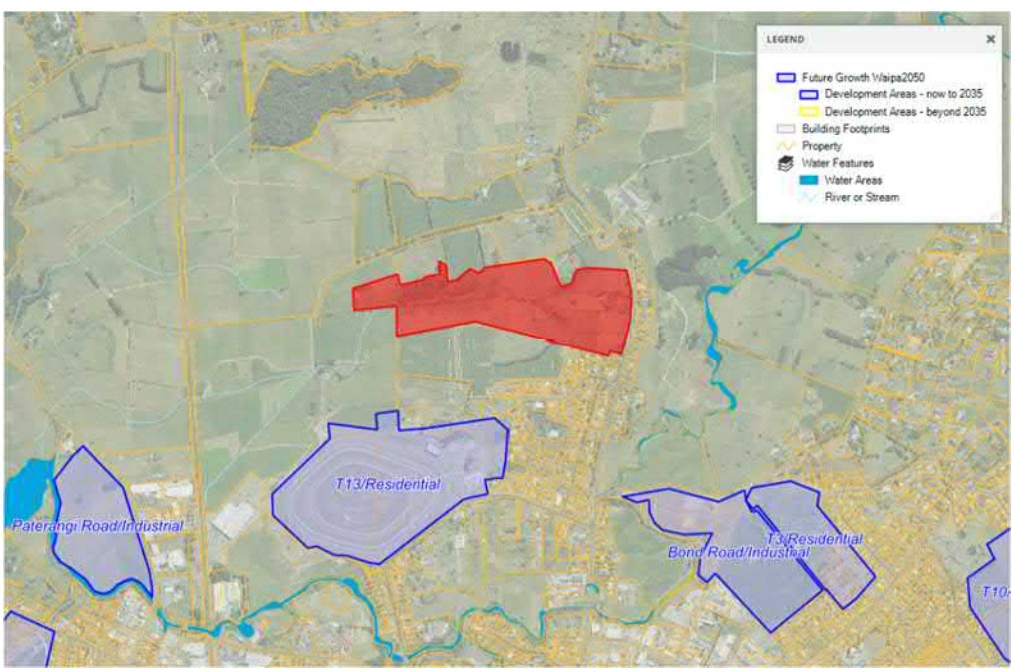

Figure 1.4: Operative Waipā District Plan Future Growth Waipā2050. The site is highlighted in red.

Figure 1.4 Source: Waipā District Council IntraMaps.

1.2 Purpose and Scope

The scope of this EcIA includes a description of the existing ecological values of the site and the surrounding area. The ecological assessment was undertaken in accordance with current Environment Institute of Australia and New Zealand Inc. (EIANZ) EcIA Guidelines[1], including determining best practice environmental management options should residual effects result from the proposal. This report provides a summary of the potential and actual effects of the proposed works on these values and identifies potential management approaches to avoid, remedy, mitigate, or where appropriate offset adverse ecological impacts.

This ecological assessment is based on the preliminary masterplan designs provided and revised during the development of this EcIA. It is recommended (if required) that a supplementary ecological statement, or revision to this EcIA is issued to cover any significant changes to the detailed design and construction methodology, to ensure that the recommendations provided within this report remain applicable and relevant to the proposed activities, impacts and mitigation measures. Recommendations in this EcIA are summarised in Section 5 to address identified potential and actual adverse effects.

1.3 Avoidance and Consideration of Alternative Options

BTW ecologists will be involved with options assessment for the master design concept and revisions of proposed engineering drawings and construction methodology. The proposed design concept will be assessed as being the best practicable option, after the consideration of alternative options. The findings of this report and other technical documents will determine the nature and scale of the proposed development, with respect to sensitive ecological receptors.

The initial proposed concept scheme plan was identified as traversing potential natural inland wetland areas. In response, a wetland delineation assessment was completed. A total of 10[3] natural inland wetlands were confirmed and delineated through the course of the assessment and investigations as part of this EcIA (see Appendix C). As stipulated in the National Policy Statement for Freshwater Management (NPS-FM)[4] and the National Environmental Standards for Freshwater (NES-F)[5], earthworks in, and within 10 metres of, a natural inland wetland is a prohibited activity.

[3] A total of nine natural wetlands were identified in an initial wetland delineation assessment completed by BTW. Following the site visit by BTW ecologists, UAV multispectral and high-resolution imagery was collected and reviewed. The multispectral data highlighted an additional potential wetland not assessed during the site visit. In the wetland delineation assessment memo this wetland is identified as WL_13 and is classed as undetermined. During the EcIA WL_13 was assessed in the field and classified as a natural wetland. Therefore, a total of 10 wetlands have been identified and delineated.

[4] New Zealand Government. NPS-FM. August 2020. National Policy Statement for Freshwater Management 2020

[5] Resource Management (National Environmental Standards for Freshwater) Regulations 2020

2 ECOLOGICAL IMPACT ASSESSMENT METHODOLOGY

The ecological assessment included a desktop review and a rapid site assessment. The site visit was completed in June 2022 and involved ecological assessment of water quality, stream health indicators, wetlands, freshwater fish, macroinvertebrates, and terrestrial flora and fauna.

2.1 Desktop Analysis

Available data sets from WRC and LINZ were reviewed as part of this EcIA, along with historical aerial imagery, the New Zealand Freshwater Fish Database, and ecological literature.

2.2 Sampling Locations

In-situ water quality measurements[6] and water sampling[7] for nitrogen[8], phosphorus[9] and environmental DNA (eDNA)[10] was completed at six locations, see Figure 2.1.

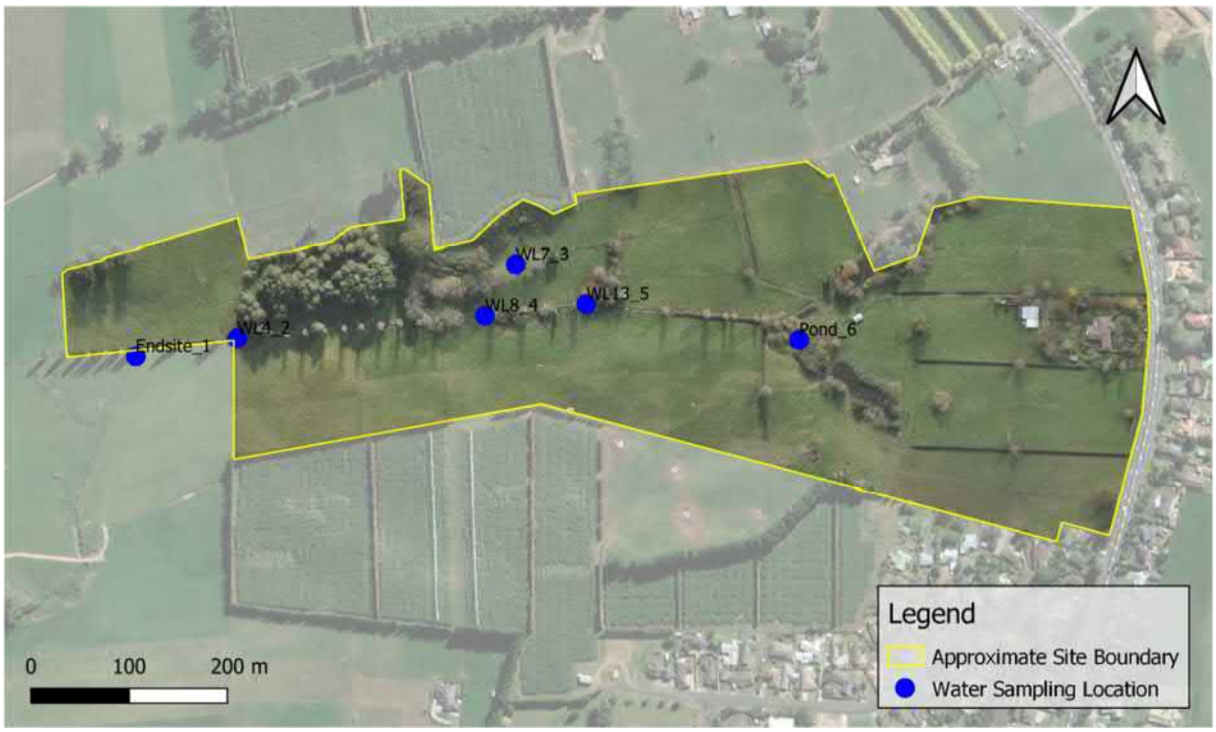

Figure 2.1: Summary of sampling locations for water quality and environmental DNA.

Figure 2.1 Site imagery collected by BTW, surrounding aerial imagery sourced from Google Satellite Map Service © 2022 Maxar Technologies.

[6] *In-situ* measurements were completed using a calibrated YSI ProDSS multiparameter probe. Recordings were taken in ponded or flowing water free of obstructions following sensor stabilisation. Variables measured were water temperature, dissolved oxygen (DO), specific conductance at 25°C, salinity, turbidity and pH.

[7] Water samples were collected in accordance with BTW and EPA guidelines. Samples were collected in clean laboratory supplied (Hill Laboratories; IANZ accredited laboratory) containers. Samples were individually labelled and stored and transported in a chilled polystyrene bin.

[8] Total nitrogen (TN), total ammoniacal (NH_4-N), nitrite (NO_2-N), nitrate (NO_3-N), total kjeldahl nitrogen (TKN).

[9] Total phosphorus (TP), dissolved reactive phosphorus (DRP).

[10] Using standard methodology outlined in Wilkinson, S. & Shaffer, M. (2020). eDNA assay guide. Wilderlab NZ Ltd.

2.3 Stream habitat

2.3.1 Taxon Independent Community Index (TICI)

The TICI is an index of stream health and is provided for each sample site (Figure 2.1). The TICI score was recently developed by Wilderlab to condense the large amount of taxonomic information retrieved in eDNA sampling to a single metric of ecological health, using tolerance values assigned to environmental DNA (eDNA) sequences.

Table 2.1: Stream ecological health ratings and categories for the Taxon Independent Community Index developed by Wilderlab

TICI Value	TICI Rating
<80	Very Poor
80-90	Poor
90-100	Average
100-110	Good
110-120	Excellent
>120	Pristine

2.4 Wetlands

Wetlands were delineated and assessed in accordance with current national guidelines and definitions, as set out in the Resource Management Act 1991, NPS-FM, NES-F and MfE (2020)[11]. Likely wetland areas within the surrounding landscape were assessed and documented during site visits, based on key indicators, such as the presence of hydrophytic vegetation, concave land topography, hydric soils and wetland hydrology. Further details of wetland delineation methodology is included in Appendix C.

2.5 Freshwater Fish

A detailed freshwater fish survey was not undertaken as part of this EcIA. However, the New Zealand Freshwater Fish Database records were reviewed as part of this assessment. Water samples were collected at each sample site and analysed for eDNA to determine the presence or absence of native and exotic fish species within the sub-catchment.

2.6 Freshwater Macroinvertebrates

Freshwater macroinvertebrate sampling was not completed however, eDNA samples were collected for indicative macroinvertebrate ecological value.

2.7 Terrestrial Habitat

A high-level site assessment to determine lizard and bat presence at the site was completed.

[11] : Ministry for the Environment. 2020. (MfE 202). Wetland delineation protocols. Wellington: Ministry for the Environment.

3 ENVIRONMENTAL AND ECOLOGICAL ASSESSMENT

Readers are directed to Appendix B (Table B 1) for a summary table of the ecological components of the site.

3.1 Review of Desktop Information

3.1.1 Climate

The Waikato region is characterised by relatively warm temperatures in the summer and relatively cold temperatures during the winter with climate variations based on location aspects such as proximity to coast, elevation, and latitude. The climate at the site is temperate, with mean annual temperatures of 13°C and average daily temperature ranges from 9.7°C to 11.9°C (based on Hamilton Aerodrome AWS data)[12]. The annual rainfall in Te Awamutu ranges from 797.5 mm to 1468 mm, with mean annual rainfall total of 1,134 mm[13].

3.1.2 Topography, Geology, and Soils

The Hamilton Basin is characterised by four main landforms, low rolling hills, alluvial plains, low terraces, and gullies[14,15]. The site is located in an area of low rolling hills (often referred to as the 'Hamilton Hills'). The rolling hills are described as ignimbrites overlaid with tephras and alluvial clays. The soil series found within the rolling hills of the Hamilton Basin are Kainui/ Ōhaupō, Hamilton and Rotokauri. The soil order found on the subject site are allophanic, brown, and gley (see Figure 3.1[16]). The soil type is mellow mesic organic[17] with a slight wetness limitation after drainage. Land use is also limited by wetness as the organic soil is a mixture of poorly and imperfectly drained soils. The site topography is presented in Figure 3.2. The site is arable with slight, moderate, and severe limitations for cultivation across the site. The New Zealand Land Use Capability (LUC) Classification system consists of eight LUC classes[18]. At the site, classes 2s, 3e and 4e are observed and presented in Figure 3.3[19]. The western side of the site is located in a low elevation area and the site has a high-water table, with groundwater approximately <1 metre below ground level.

[12] Chappell, P.R. The Climate and Weather of Waikato. 2nd Edition. NIWA science and technology series. Number 61. ISSN 1173-0382.

[13] https://waikatoregion.govt.nz/environment/envirohub/environmental-maps-and-data/station/41893/RF?Dt=Rainfall

[14] Lowe, D.J. 2010. Introduction to the landscapes and soils of the Hamilton Basin. In: Lowe, D.J.; Neall, V.E., Hedley, M; Clothier, B.; Mackay, A. 2010. Guidebook for Pre-conference North Island, New Zealand „Volcanoes to Oceans" field tour (27-30 July). 19th World Soils Congress, International Union of Soil Sciences, Brisbane. Soil and Earth Sciences Occasional Publication No. 3, Massey University, Palmerston North, pp. 1.24-1.61.

[15] Hewitt A.E., Balks M.R., Lowe D.J. (2021) Organic Soils. In: The Soils of Aotearoa New Zealand. World Soils Book Series. Springer, Cham. Https://doi.org/10.1007/978-3-030-64763-6_8

[16] Data sourced and adapted from LRIS portal (lris.scinfo.org.nz/), LINZ data service (data.linz.govt.nz/), Ministry for the Environment (data.mfe.govt.nz/) under Creative Commons Attribution 3.0 and Creative Commons Attribution 4.0 International.

[17] Mesic organic soils occur in very wet sites or in sites that have been artificially drained and the peat materials are moderately decomposed.

[18] Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF 2009. Land Use Capability Survey Handbook – a New Zealand handbook for the classification of land 3rd ed. Hamilton, agresearch; Lincoln, Landcare Research; Lower Hutt, GNS Science. 163p. ISBN 978-0-477-10091-5.

[19] Subject to a site-specific LUC Assessment

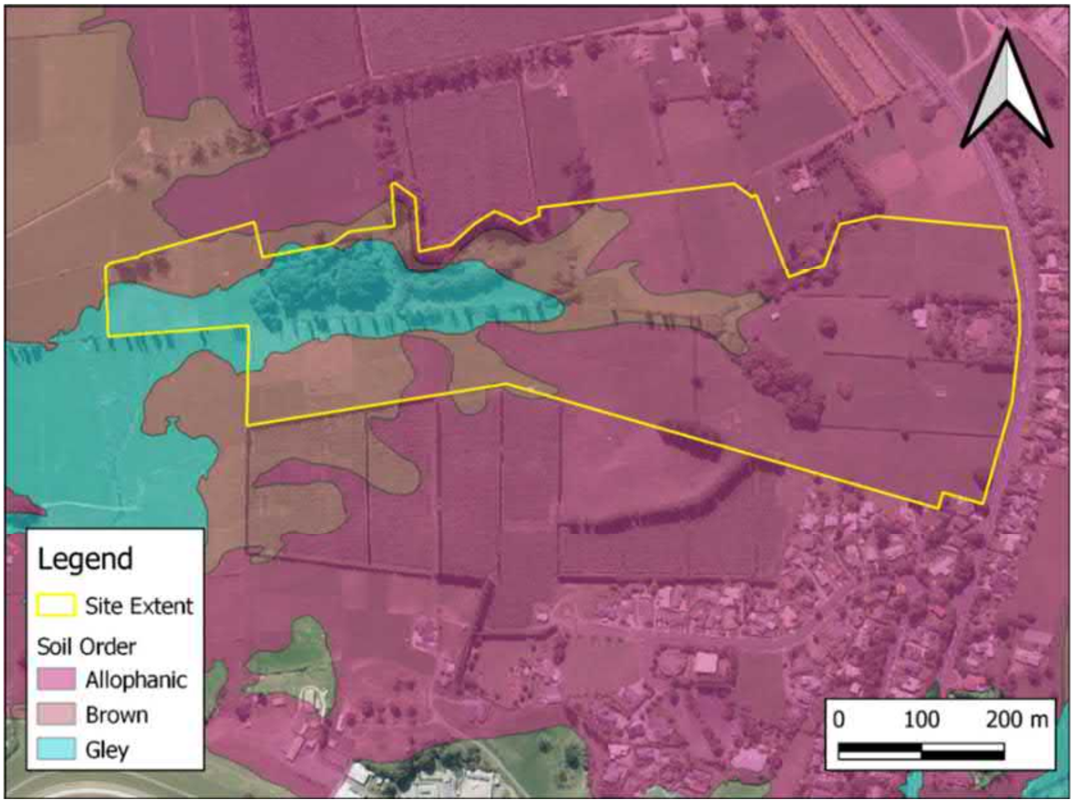

Figure 3.1: Site soils order[16].

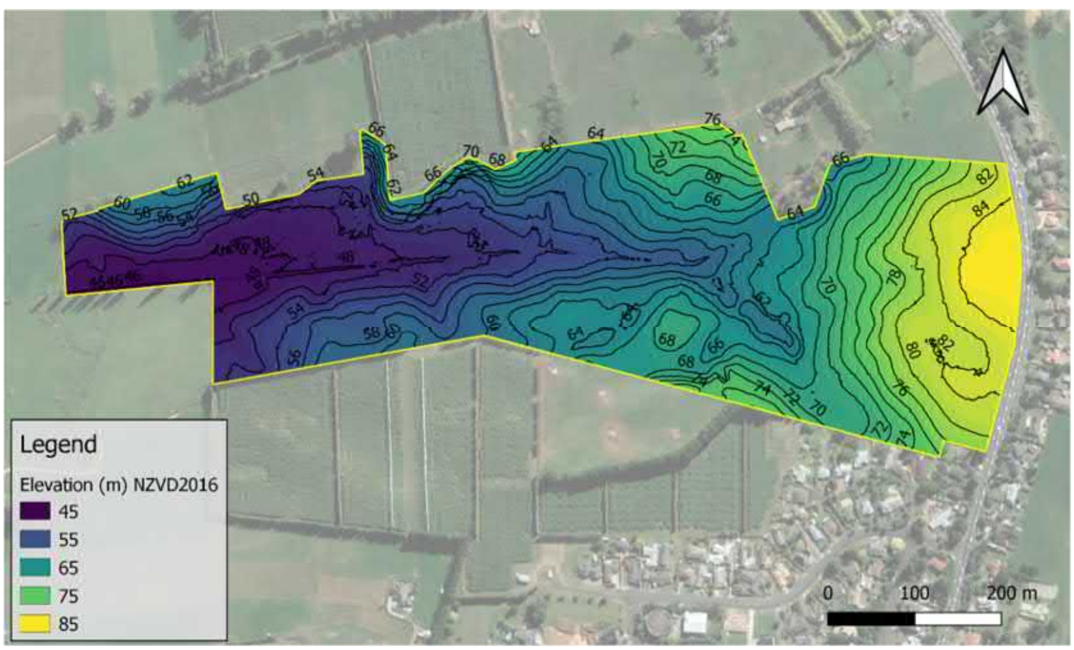

Figure 3.2: Site topography (NZVD 2016).

Figure 3.2 Site imagery collected by BTW, surrounding aerial imagery sourced from Google Satellite Map Service © 2022 Maxar Technologies.

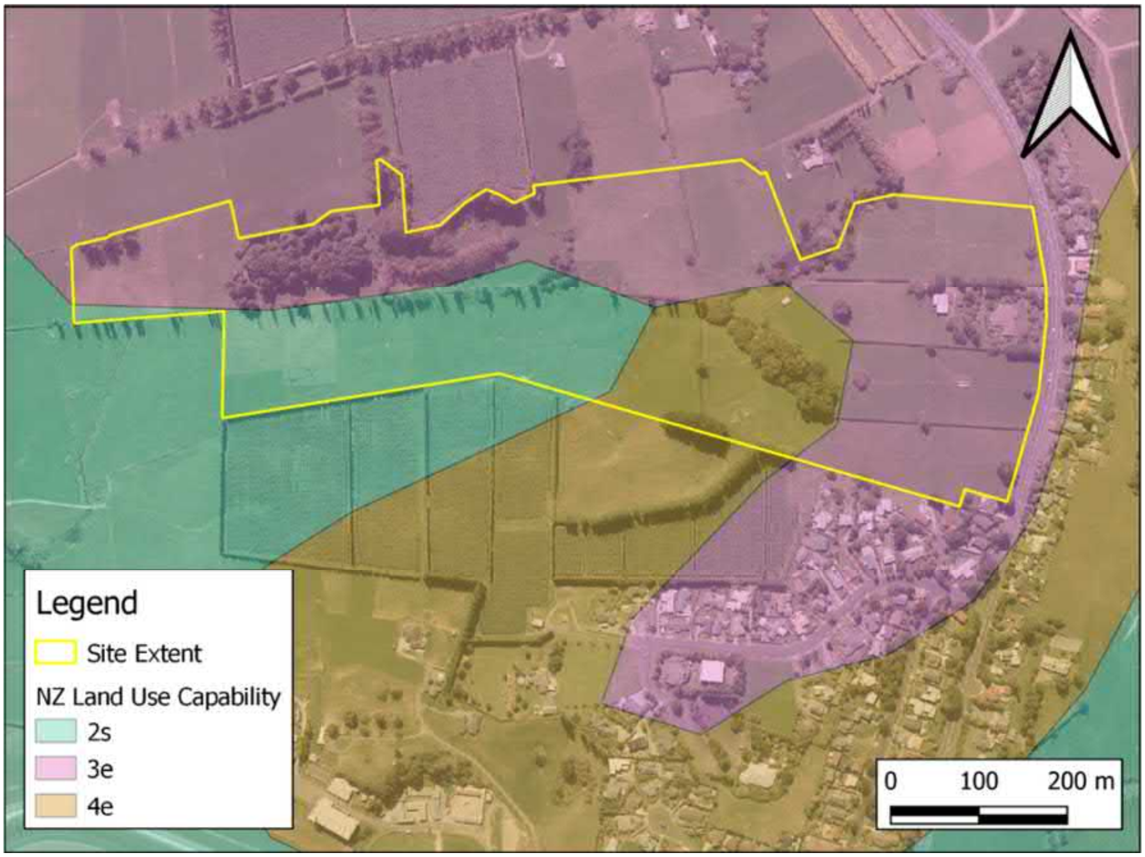

Figure 3.3: New Zealand Land Use Capability (LUC) Classification[16] (subject to a site-specific LUC Assessment)

3.1.3 Hydrology and Water Quality

The site is situated in the Waipā catchment, covering 306,569 ha and consisting of 4,825 km of mapped stream and river channels and 14 peat lakes. The Waipā River is the single largest tributary of the Waikato River and is the largest contributor of sediment to the Waikato River system, supplying 67% of the total load of the lower Waikato River. The peat lakes within the catchment are valued for their unique genetic diversity, scientific interest and as a valuable habitat for many unique animals and plants, but are under threat due to drainage, nutrients, plant and animal pests, and contaminants (e.g., cadmium from fertilisers). The peat lakes, Lake Ngaroto, Lake Ngarotoiti, Lake Serpentine (Lake Rotopikpo), and Lake Rotopotaka, are within 6 km of the site and fall within the Waipā catchment, see Figure 3.4.

All surface water from the site appears to feed into a central watercourse flowing from east to west (Figure 3.5) and generally follows site topography (Figure 3.2). The central watercourse discharges into an unnamed tributary of the Mangapiko Stream at the south-western end of the site, and eventually into the Waipā River. There are two constructed amenity ponds on the eastern side of the property. WaikatoMaps groundwater database records showed no groundwater bores located on the site, but several located within the wider area. The groundwater data provided by WRC was reviewed, but no water quality was available. The authors assume that groundwater flows generally follow the topographic contours and therefore the site is unlikely to be hydrologically connected to the nearby peat lakes.

WRC monitoring includes water quality data from 1993 to 2022 for Lakes Rotopiko, Ngaroto, Rotomanuka, and the Mangapiko Stream[20].

Rudd (*Scardinius erythrophthalmus*) pest fish monitoring and removal for Lake Rotopiko[21] was undertaken by WRC in 2003[22], which reported high numbers of rudd, although the lake is located approximately 5 km from the site and the two locations are not ecologically or hydrologically connected.

On a wider scale, WDC invertebrate monitoring indicates that the habitat quality of streams in the Waipā catchment is below average regionally, while ecological health is around the regional average. Habitat quality and ecological health in streams ranges from poor to excellent across the zone, depending on the upstream land use.

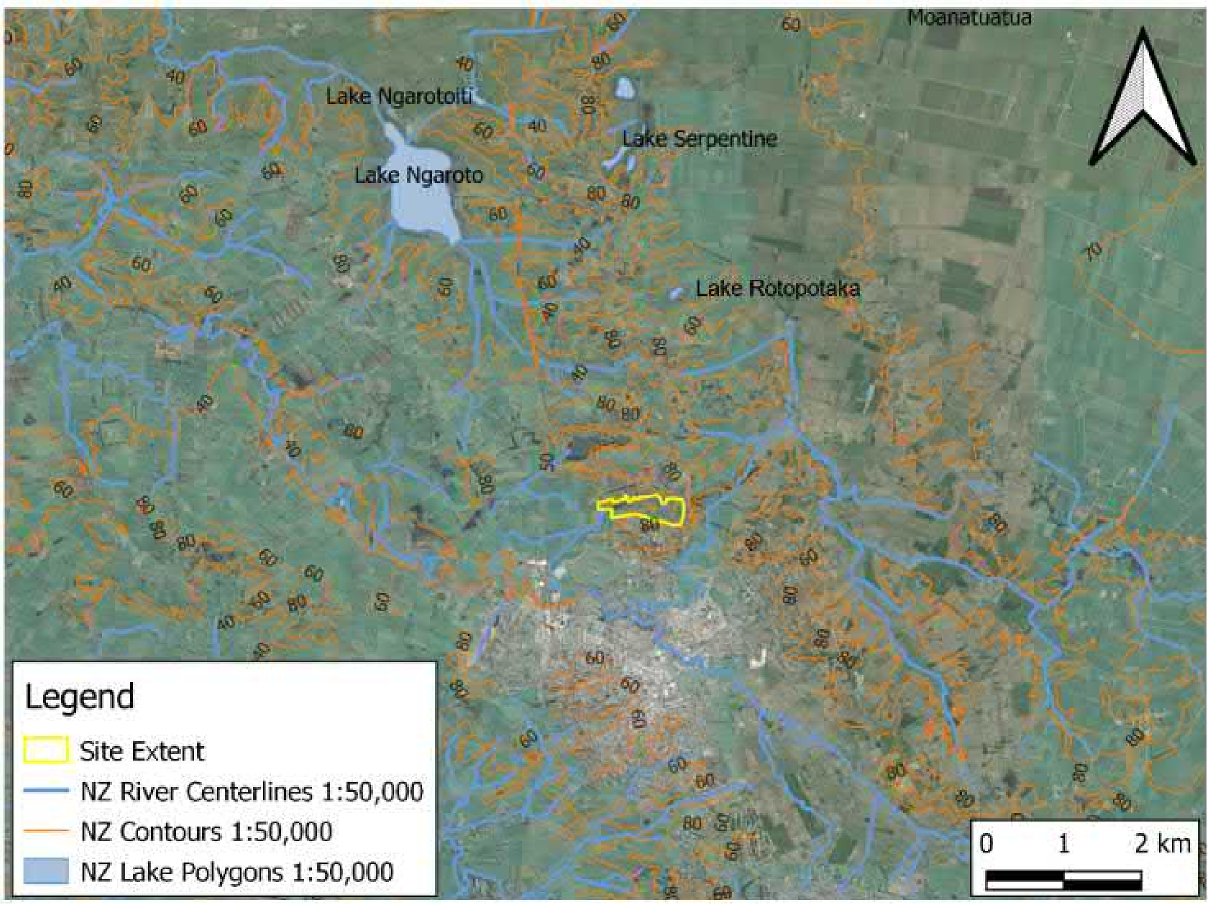

Figure 3.4: Topographic contours (orange) and hydrology surrounding the site (light blue)[16].

Figure 3.4 Aerial imagery sourced from Google Satellite Map Service © 2022 Maxar Technologies.

[20] Water quality variables monitored include: Calcium, chloride/chlorine, dissolved oxygen, dissolved reactive phosphorus, electrical conductivity, potassium, magnesium, sodium, ammonium, nitrate, nitrogen, nitrite, pH, total phosphorus, turbidity, zinc, total anions, total cations.

[21] Also known as Lake Serpentine.

[22] Barnes, G. (2003). Control of Rudd at Lake Rotopiko – Progress Report.

Figure 3.5: Site watercourses and flow direction.

Figure 3.5 Site imagery collected by BTW, surrounding aerial imagery sourced from Google Satellite Map Service © 2022 Maxar Technologies.

3.1.4 Ecology and Biodiversity Features

The site and surrounding area is predominantly pastoral agriculture and falls within both the Hamilton Ecological District[23] and the Waipā Ecological District[24] (the boundaries of these districts meet and intersect the site). Both these ecological districts are within the Waikato Ecological Region[25].

A number of areas of ecological importance are within the wider area, such as indigenous forests, wetlands, and peat lakes[26]. Notably, to the north of the site is the drained Moanatuatua Bog (see Figure 3.4 for location). The bog was formed 14,000 years ago[27] and was formerly ~ 7500 - 8500 ha in size. Moanatuatua is now 140 ha following drainage and conversion to agriculture[28,29]. This bog represents the best remaining example of a restiad rushland in the Hamilton Ecological District.

[23] https://www.inaturalist.org/places/hamilton-ecological-district

[24] https://www.inaturalist.org/places/waipa-ecological-district

[25] https://www.inaturalist.org/places/waikato-ecological-region

[26] See Operative Waipa District Plan for further details.

[27] Clarkson, B., Thompson, K., Schipper, L., & Mcleod, M. (1999). Moanatuatua Bog—Proposed Restoration of a New Zealand Restiad Peat Bog Ecosystem.

[28] Schipper, L.A. and McLeod, M. (2002) Subsidence Rates and Carbon Loss in Peat Soils Following Conversion to Pasture in the Waikato Region, New Zealand. Soil Use and Management, 18, 91-93. https://doi.org/10.1111/j.1475-2743.2002.tb00225.x

[29] Clarkson, Beverley R.; Schipper, Louis A.; Lehmann, Anthony (2004). "Vegetation and peat characteristics in the development of lowland restiad peat bogs, North Island, New Zealand". Wetlands. 24 (1): 133–151. ISSN 0277-5212.

Approximately 750 m north of the site is the largest kahikatea (*Dacrycarpus dacrydioides*) remnant in the Waipā District (WP309, WP309a; 13.5 ha). At the site, a kahikatea stand (WP312[30]) is located at in the west. Both these kahikatea forests are defined as potential significant natural area (SNA), see Figure 3.6.

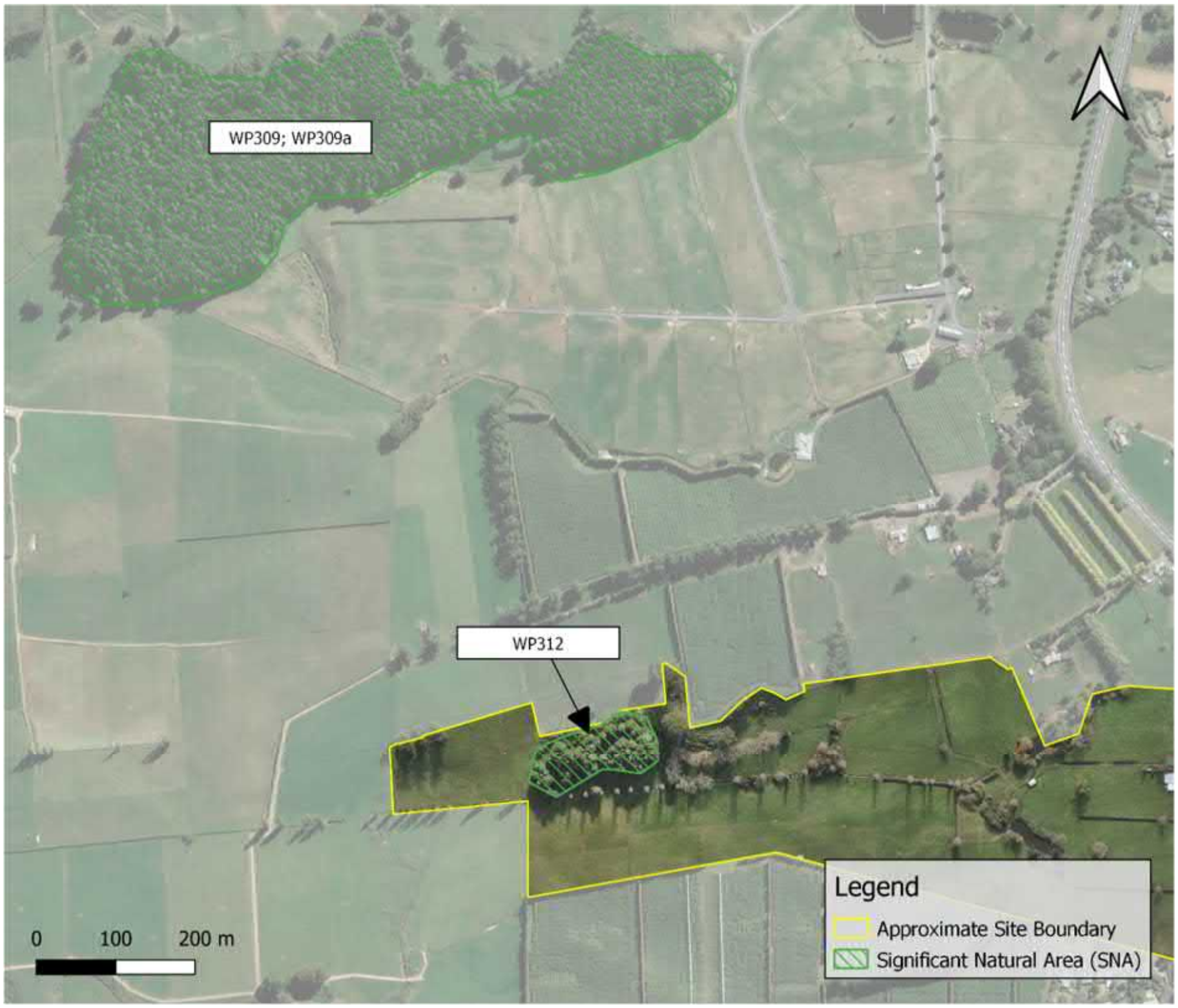

Figure 3.6: Kahikatea (*Dacrycarpus dacrydioides*) remanent forests identified as potential significant natural area (SNA).

Figure 3.6 data source: Operative Waipā District Plan biodiversity information[30]. Site imagery collected by BTW, surrounding aerial imagery sourced from Google Satellite Map Service © 2022 Maxar Technologies.

3.1.5 Historical Imagery and Land Use Changes

Historical aerial imagery indicates the site has been used for agricultural grazing since 1943 to the present day (Figure 3.7, Figure 3.8).

The Waipā River catchment once contained a diverse range of indigenous ecosystems including streams, rivers, lakes, wetlands, karst, forest and shrublands. These ecosystems provide critical

[30] Intramaps and Property Information. (2022). Waipa District Council.

habitats for indigenous fauna, flora and microorganisms. They also provide a range of fundamental ecological functions, such as acting as buffer zones for other ecosystems in the region, reducing erosion and downstream sedimentation, reducing the effects of high flows and flooding, nutrient storage and recycling, and break down and absorption of pollutants.

Since 1840, almost all of the native vegetation in the low-lying valleys has been converted to pasture/agricultural use. This includes almost all of the significant wetland areas, which have been drained, leaving behind only remnant pockets of wetlands and shallow peat lakes. The main tributaries of the Waipā River are characterised by relatively low gradient, sinuous and sluggish channels that have been significantly changed in some areas through historic works. Those works typically included clearing, enlarging and shortening the channels through diversions to improve channel efficiency and reduce flooding and damage to the pastureland.

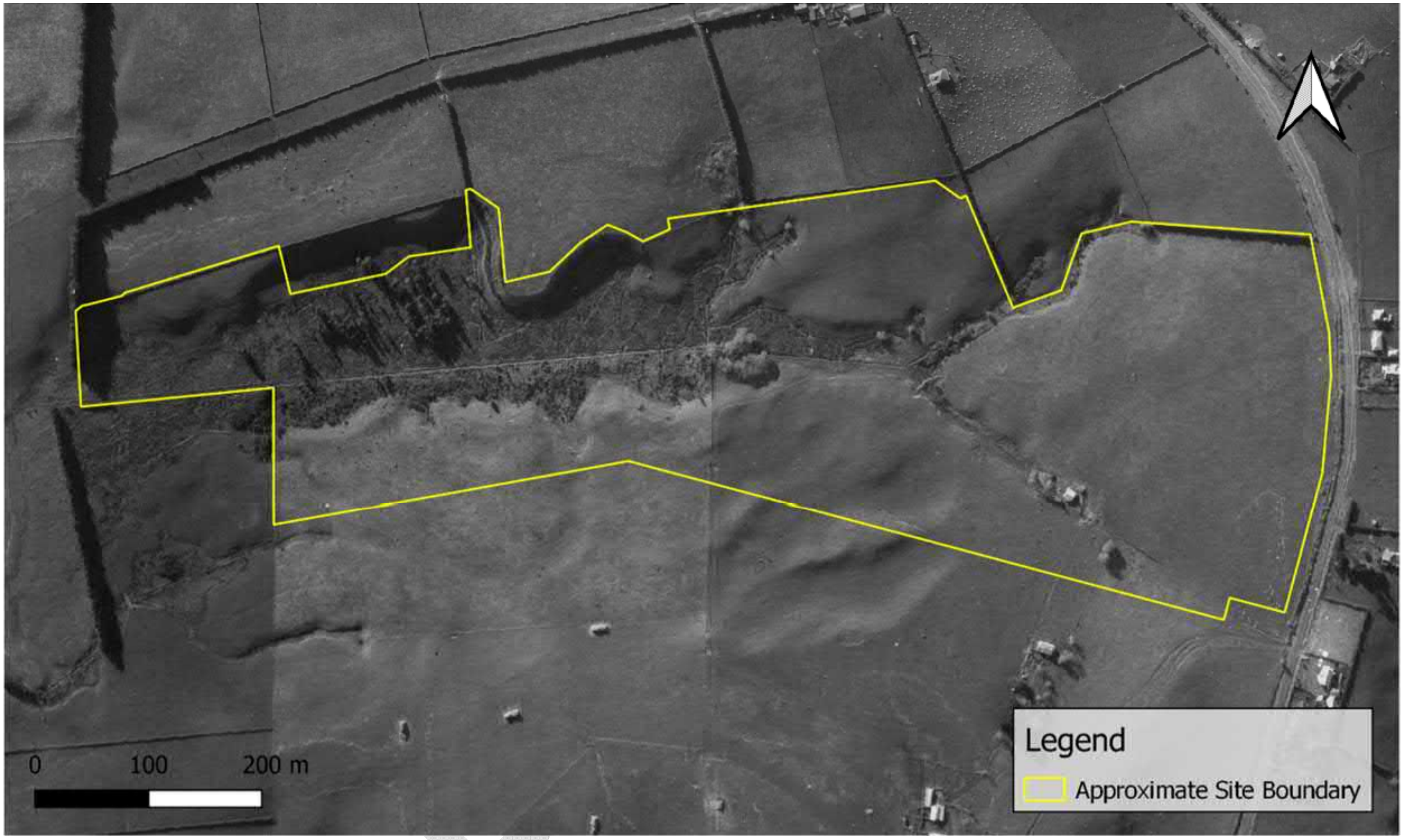

Figure 3.7: 1943 aerial image of the site.

Figure 3.7 Image source: http://retrolens.nz and licensed by LINZ CC-BY 3.0 and georeferenced by BTW.

Figure 3.8: 2022 aerial image of the site.

Figure 3.8 Site imagery collected by BTW, surrounding aerial imagery sourced from Google Satellite Map Service © 2022 Maxar Technologies.

3.2 Water Quality Data

At all sampling sites dissolved oxygen (DO) was greater than the 8 mg/L, and pH ranged from 6.43 to 6.92. Figure 3.9 presents an overview of water total nitrogen (TN), ammoniacal nitrogen (NH4-N), nitrate (NO3-N), dissolved reactive phosphorus (DRP), and total phosphorus (TP). The concentrations are compared to ANZECC default trigger values[31,32]. Full dataset is presented in Appendix E.

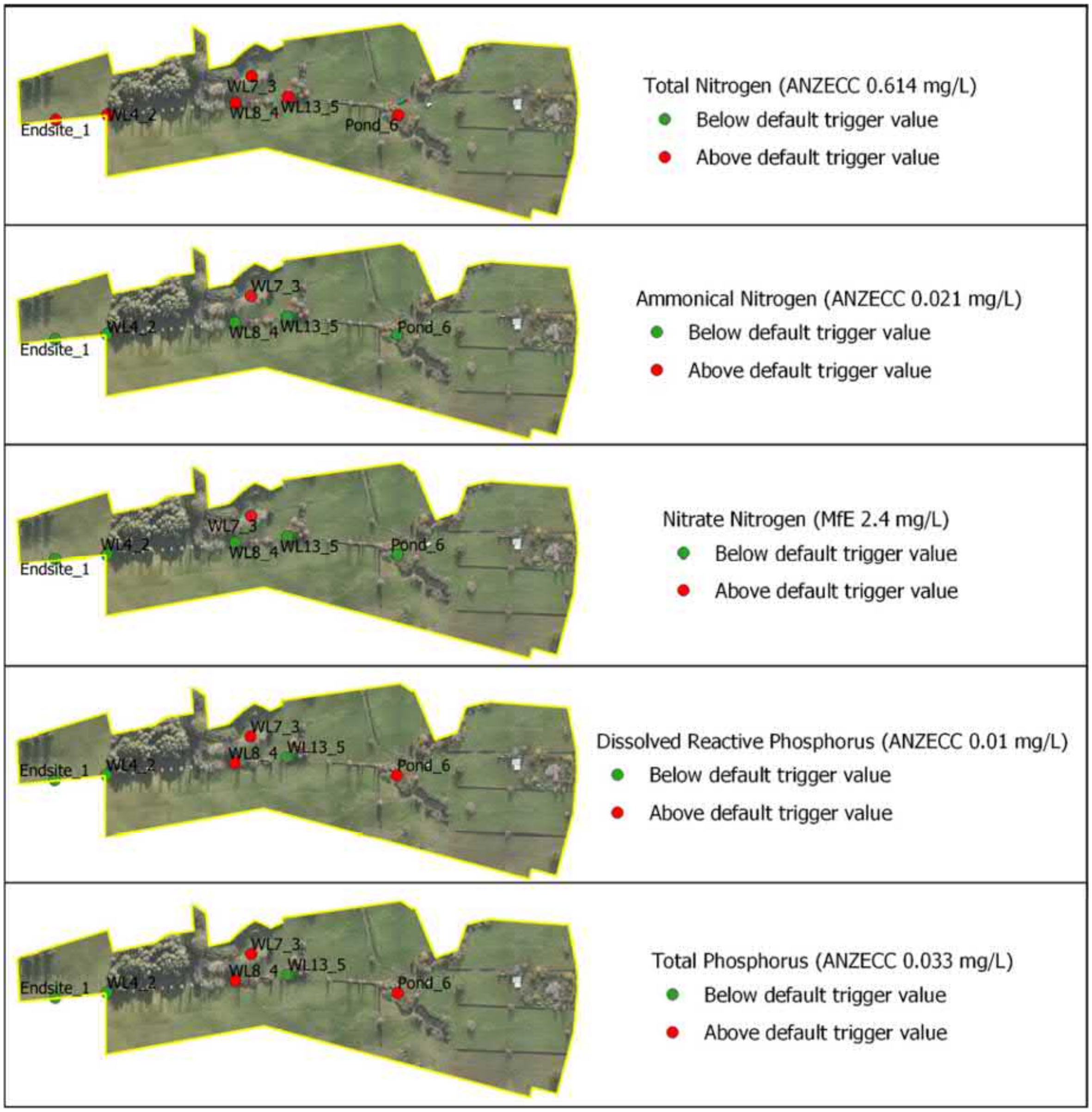

Figure 3.9: Water quality data summary and comparison to applicable trigger value. Image source: BTW.

[31] ANZECC default trigger values for physical and chemical stressors in New Zealand for slightly disturbed ecosystems to assess the risk of adverse effects due to nutrients.

[32] The ANZECC/ARMCANZ (2000) default guideline value for nitrate was erroneous. In the absence of an ANZG (2018) default guideline value, the MfE (2013) report authored by Hickey, C.W. 2013. Titled: Updating nitrate toxicity effects on freshwater aquatic Species is used.

3.3 Wetlands and Stream Habitat

The key freshwater ecological features of site are wetlands and watercourses that feed into a central channelised watercourse. The central watercourse is an unnamed tributary of the Mangapiko Stream and is classified as a modified watercourse[33,34] (see Figure 3.10 for example of the central watercourse). Multiple discharge points for water to flow into the central site watercourse were observed, from spring-fed streams, natural inland wetlands, drainage ditches, and ponds.

Figure 3.10: Typical reach of the central watercourse at the site.

A wetland identification and delineation assessment[35] was completed prior to the EcIA assessment (see Appendix C). The wetland assessment confirmed a total of nine wetlands and classified an additional wetland as undetermined (WL_13)[36]. During the EcIA site visit, the wetland (WL_13) classified as undetermined was confirmed to be a natural wetland. Therefore, a total of 10 highly disturbed and degraded[37] wetlands were identified at the site. Figure 3.11 outlines the location of the 10 wetlands all located within the lower elevation areas of the site (Figure 3.12), and within the extents of the historical marsh evident in 1943 imagery (Figure 3.13). The historical imagery highlights the fragmentation of historical marshland into discrete wetland areas from pastoral agricultural land use.

[33] Modified watercourse: An artificial or modified channel that may or may not be on the original watercourse alignment and which as a natural channel at its headwaters (according to WRC Regional Plan).

[34] Waikato R. (2007). Waikato Regional Plan. Environment Waikato Policy Series, 21. Revised 2021.

[35] In accordance with Ministry for Environment Wetland Delineation Protocols.

[36] Wetland was highlighted during review of multispectral and high-resolution aerial imagery.

[37] Pugging in unfenced locations and replacement of wetland vegetation with pasture species.

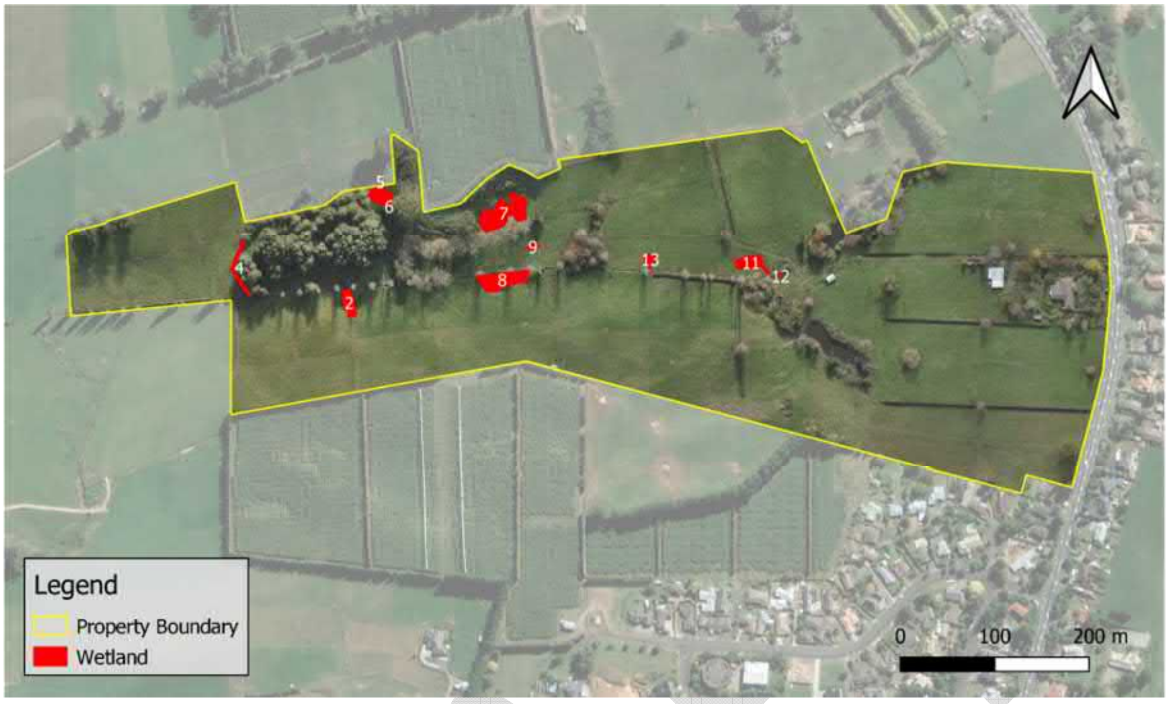

Figure 3.11: 2022 aerial image of the site overlaid with identified wetlands.

Figure 3.11 Site imagery collected by BTW, surrounding aerial imagery sourced from Google Satellite Map Service © 2022 Maxar Technologies.

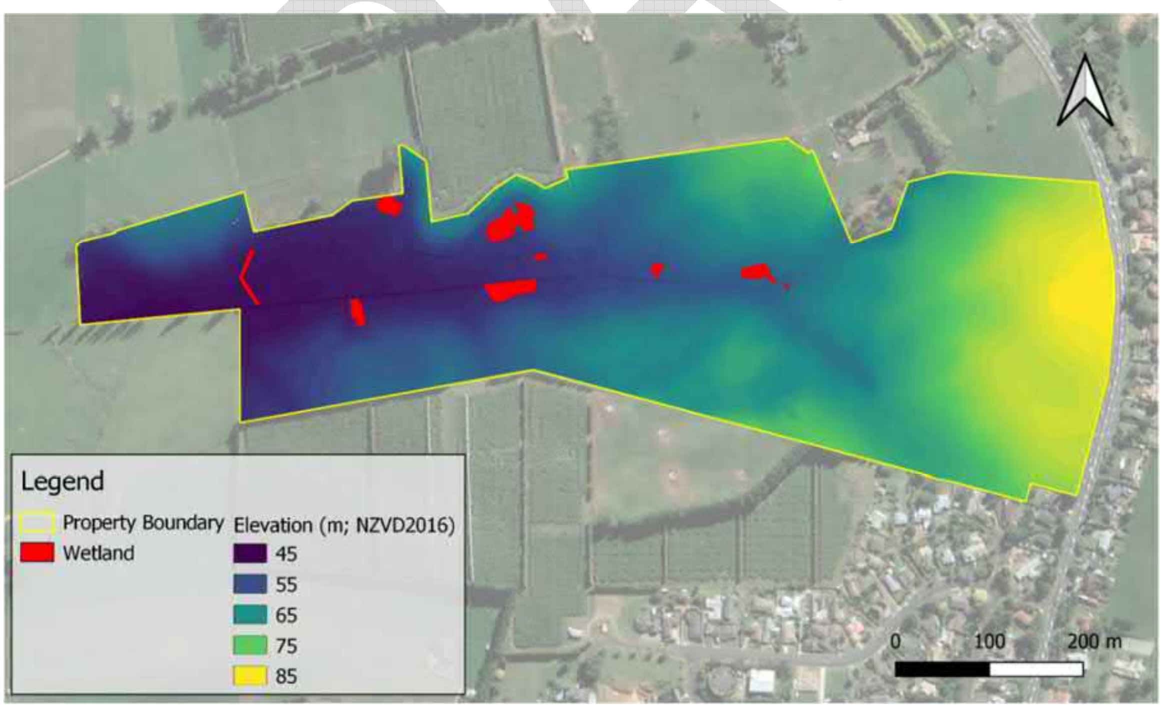

Figure 3.12: Site topography (NZVD 2016) and wetlands.

Figure 3.12 Aerial image sourced from Google Satellite Map Service © 2022 Maxar Technologies.

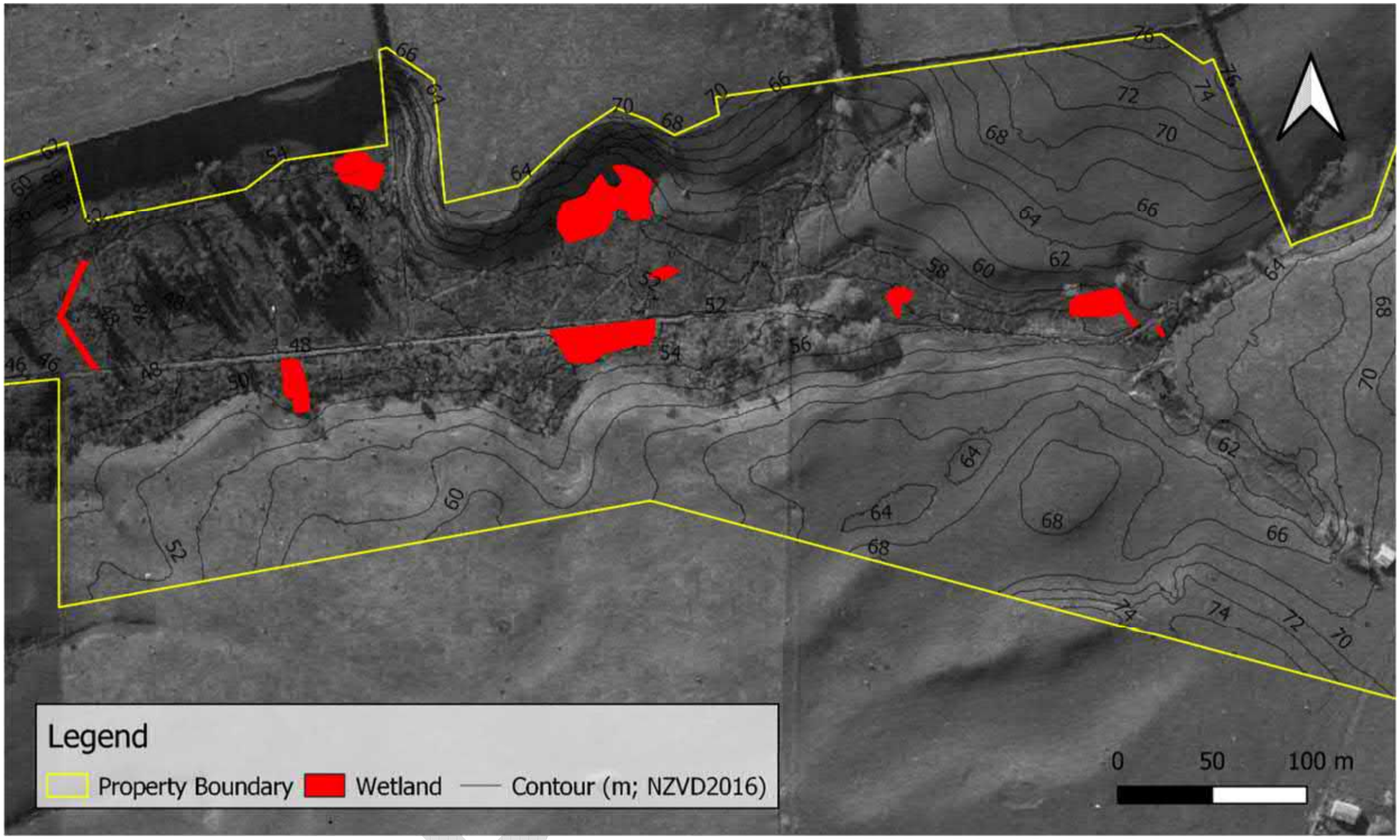

Figure 3.13: 1943 aerial image of the site with 10 identified natural wetlands and elevation contours (NZVD2016).

Figure 3.13 Image source: http://retrolens.nz and licensed by LINZ CC-BY 3.0 and georeferenced by BTW.

3.3.1 Ecological Value Summary: Wetlands

Overall, the wetland areas are of High ecological value based on current EIANZ EcIA guidelines. The identified wetlands are groundwater-fed and have suffered historic disturbance through agricultural land use so are partial degraded in condition. As a result of the wetland assessment, the subdivision design and development layout were modified to avoid any impacts on these high value ecological units.

As such, its recommended that wetland ecological minimisation measures be considered in the subdivision detailed design process to incorporate enhancement opportunities and to ensure post development stormwater inputs are consistent with predevelopment inputs.

3.3.2 Ecological Value Summary: Stream Habitat

Overall, the stream habitat across the site were assessed as having low existing ecological values, based on current EIANZ guidelines. Current stream habitat contained limited ecological value other than local habitat for tolerant native species, which have adapted to the partial degraded ecosystem and poor water quality with respect to excessive nutrient inputs.

The agricultural land use and historic stream drainage within the catchment have adversely impacted stream morphology and water quality within the tributaries and stormwater drains. All the selected sample sites rate Low for each of the Representativeness, Rarity/Distinctiveness, Diversity and Pattern, and Ecological Context matters set out in Table 7 of the guidelines[7], given the poor community complexity, diversity, representativeness of the degraded stream habitat.

3.4 Fish and Macroinvertebrates

An environmental DNA (eDNA) sample was collected from each of the six sampling sites, to characterise the existing ecological values of the sample sites, with respect to freshwater fish and stream invertebrates.

3.4.1 Taxon Independent Community Index

TICI scores rated as "Poor", "Average", or "Good", indicating a macroinvertebrate community with Moderate TICI rating, when compared with other streams from across the country (Table 3.1).

Table 3.1: Taxon Independent Community Index (TICI) results for the four sample sites, based on Wilderlab eDNA results.

eDNA Sampling Location	TICI Value	TICI Rating	TICI nsegs	TICI Reliability
Endsite_1	89.18	Poor	293	High
WL4_2	92.04	Average	315	High
WL7_3	100.98	Good	293	High
WL8_4	92.51	Average	286	High
WL13_5	91.66	Average	296	High
Pond_6	86.39	Poor	122	Low

3.4.2 Fish

Only two fish species were detected in the eDNA samples, the predatory shortfin tuna/eel (*Anguilla australis*) and gambusia/mosquitofish (*Gambusia affinis*). The shortfin eel was the most abundant fish and was present at all six sites. In comparison, gambusia was only present at Endsite_1 and WL4_2, the sites located furthest downstream.

Gambusia are likely outcompeting native species due to aggressive behaviour and more favourable habitat conditions (e.g., gambusia are more tolerant of high temperatures and salinity). Further, aggression is increased in gambusia with temperature-sensitive genotypes adapted to higher temperatures[38,39].

Native fish species such as the 'At risk -declining' long fin tuna/eel (*Angulia dieffenbachia*), the black mudfish (*Neochanna diversus*), Gobiomorphus/bullies and multiple kokopu species were not identified in the eDNA, however, suitable habitat exists for banded and giant kokopu within the flowing watercourse and potentially black mudfish in the larger wetland areas, away from the predatory shortfin tuna.

3.4.3 Macroinvertebrates

A range of freshwater macroinvertebrates, including flies, snails, and crustaceans were detected in the eDNA sampling, although no threatened or at-risk species were recorded. The eDNA results found a number of species with high tolerance values include a *Diptera* (true fly), other true flies (4.5), *Austrosimulium australense* (sandfly), and a *Lepidoptera* (butterfly or moth) species (1.3)[40]. Additionally, a number of caddisfly species were detected including *Oeconesus maori* (micro caddisfly), *Psilochorema* (Endemic New Zealand caddisfly) species with tolerance values of 6.4 and 7.8, respectively. The highest eDNA sequence counts at each site were attributed to copepods and worms. Overall, there was little difference in macroinvertebrate counts at each site and no one site was favoured by a particular group.

3.4.4 Ecological Value Summary: Freshwater Fish and Macroinvertebrates

Based on the presence of common native species and pest fish the ecological value for freshwater fish according to Table 5 of the EIANZ EcIA guidelines[1] is Low.

Based on available data all sample sites were assessed as having Low value for freshwater macroinvertebrates, according to Table 5 of the EIANZ EcIA guidelines[1].

3.5 Terrestrial Ecology

3.5.1 Terrestrial Vegetation

The site is predominantly pasture with exotic trees species including large poplars (*Populus* sp) lining the central watercourse and mature eucalyptus trees located on the banks above the kahikatea stand. The historical imagery suggests the site has been cleared of indigenous vegetation prior to 1943 and replaced with pastoral grasses for agricultural land use.

Overall, the ecological value of on-site vegetation in the areas of pasture was considered low and/or very low. Whereas the kahikatea stand, and associated wetland vegetation were considered high value. There were no at-risk or threatened plant species observed at the site.

[38] Becker, A., Laurenson, L. J., Jones, P. L., & Newman, D. M. (2005). Competitive interactions between the Australian native fish Galaxias maculatus and the exotic mosquitofish Gambusia holbrooki, in a series of laboratory experiments. Hydrobiologia, 549(1), 187-196

[39] Horth, L. (2003). Melanic body colour and aggressive mating behaviour are correlated traits in male mosquitofish (Gambusia holbrooki). Proceedings of the Royal Society of London. Series B: Biological Sciences, 270(1519), 1033-1040

[40] Stark, J. D., & Maxted, J. R. (2007). A user guide for the Macroinvertebrate Community Index. Nelson, New Zealand.

3.5.2 Terrestrial Fauna (bats)

An EcIA completed at Frontier Road, approximately 5 km from the site detected bat activity along a wetland gully and in the exotic trees present. As part of this EcIA, all trees were visually searched for bats roost, with the deciduous exotic trees lacking leaf allowing for a comprehensive search, with no bat roosts recorded.

Intensive acoustic bat surveys were not undertaken during this EcIA as mature trees are to remain as part of the proposal.

The long-tailed bat is classified as *Threatened – Nationally Critical*[41] due to predation, habitat degradation and/or habitat loss. Native bats are 'absolutely protected' under the Wildlife Act (1953 so the ecological value of the site for bats was assessed as high even in the absence of bat roosts, as long tail bats could potentially use the area during nightly feeding.

3.5.3 Avifauna (birds)

Bird species utilising the site were a mix of common native and non-native species, with the mature trees and wetland areas providing habitat for bird species. No bird survey was undertaken as part of this EcIA, but conspicuous bird species were recorded during the site visits, with no at risk or threatened bird species observed during the site assessments.

The ecological value of the site for avifauna was assessed as low, except for providing local habitat for tolerant native and introduced species.

3.5.4 Herpetofauna (lizards)

A high-level site assessment was undertaken to determine lizard species which are likely to be found within the vegetation clearance area. The habitat quality for lizards across the site was generally poor due to historical vegetation clearance for pastoral agriculture. Nonetheless, suitable habitat for the native copper skink (*Oligosoma aeneum*) (declining[42] was present at the site, within the areas of rank grass, weedy areas and wooded debris piles.

A detailed herpetofauna/lizard survey was not undertaken as part of this EcIA, given the lack of suitable habitat available on the grazed pasture areas, however, due to the potential copper skink habitat the ecological value of the site was assessed as moderate for herpetofauna.

3.6 Ecological Value Summary: Terrestrial Ecology

On-site assessments and available data for the site indicated the site has moderate ecological value for terrestrial ecology, considering the presence of wetlands and potentially fauna species in the kahikatea stand SNA[43].

[41] O'Donnell, C.F.J.; Borkin, K.M.; Christie, J.E.; Lloyd, B.; Parsons, S.; Hitchmough, R.A. 2018: Conservation status of New Zealand bats, 2017. New Zealand Threat Classification Series 21. Department of Conservation, Wellington. 4 p. http://www.doc.govt.nz/Documents/science-and-technical/nztcs21.pdf

[42] Hitchmough, R., Barr, B., Lettink M., Monks, J., Reardon, J., Tocher, M., van Winkel, D. and Rolfe, J. 2015. New Zealand Threat Classification Series 17. Department of Conservation, Wellington. 4 p Conservation station of New Reptiles, 2015

[43] Table 5 EIANZ EcIA Guidelines.

4 ECOLOGICAL IMPACT ASSESSMENT

This section outlines the impact assessment in absence of ecological management measures and provides recommendations to avoid, minimise, remedy, and offset actual and potential ecological impacts.

4.1 Activity description

As outlined in Section 1.1 the proposed activity is to develop a residential subdivision at the site. The subdivision will require access roading, and right of ways to provide access to properties. Based on the preliminary concept masterplan (Figure 4.1), the main access way will require three watercourse crossing points that are most likely large, embedded culverts.

Earthworks across the site will also be required to facilitate the subdivision infrastructure, such as water, stormwater and subsurface infrastructure networks, alongside power supply, and levelling for housing platforms.

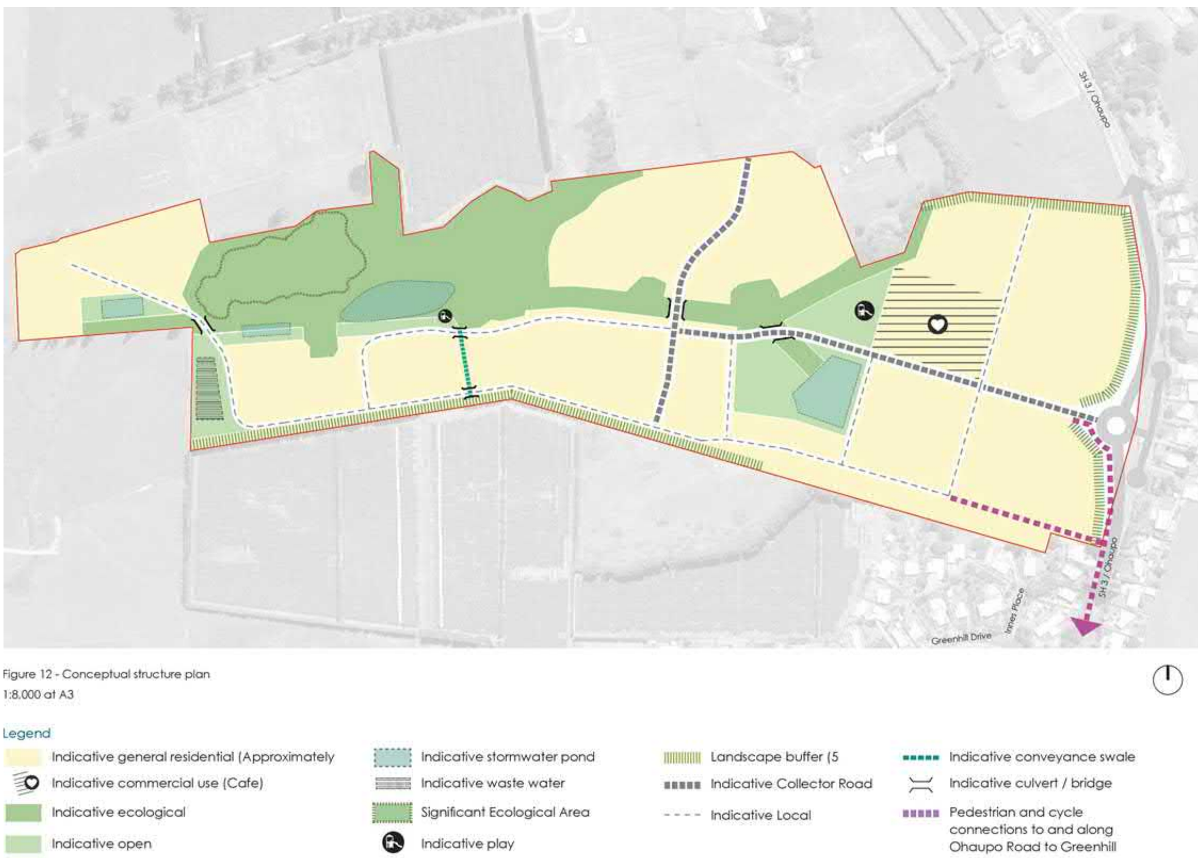

Figure 4.1: Conceptual Structure Plan

The following sections of the EcIA make ecological impact assessments in both short- and long-term time frames based on the subdivision concept plan (Figure 4.1). Importantly, the key objective of this EcIA is to inform future iterations of master design options. As the concept plan is developed further there may be a need for this EcIA to be updated so that the impact assessment and mitigation package is relevant and the continues to be accurate.

4.2 Watercourse Crossing Impact Assessment

A total of three vehicle watercourse crossings are presented in the preliminary design. In addition, a total of six pedestrian crossings are proposed. All pedestrian crossings are assumed to be footbridges and are not assessed any further in this EcIA. In comparison, vehicular crossings are most likely to be culvert designs and assessed as such ((i.e., culvert stream crossing has higher potential impact in comparison to single span bridges).

Based on the information provided in the preliminary masterplan, the culverted watercourse crossings will meet the permitted activity status for the National Environmental Standard for Freshwater (NES-F)[44]. Although the culverts will meet the NES-F, an ecological impact assessment of each culvert crossing is required for the potential loss of ecological value and/or ecosystem function from placement of the culvert structure in the bed of the water course. Section 4.3 presents location, aerial imagery, size, and freshwater ecological aspects for each crossing.

The actual and potential adverse effects on ecological values have been assessed for temporary, long term and permanent timescales of effects[45]. Temporary effects, typically occurring at the construction phase, are related to impacts to aquatic ecology through temporary uncontrolled stormwater/sediment discharges and bulk earthworks and may include the direct mortality of aquatic fauna, such as fish and macroinvertebrates. Effects following the completion of works include potential (but unknown) contaminants entering stormwater from road derived and residential runoff and changes to baseline ecological value and ecosystem functioning from installation of culverted stream crossings.

Potential long-term effects, occurring at the >25 years scale, are related to direct and indirect impacts such as creation of fish barriers, vegetation disturbance, post construction flooding and stream erosion, and the proliferation of weed and pests from inadequately designed and managed revegetation efforts. Subsequent sections outline ecological management measures and recommendations to inform updates to masterplan.

[44] Resource Management (National Environmental Standards for Freshwater) Regulations 2020

[45] Table 9. EIANZ.

4.3 Freshwater Ecology: Stream Crossings

4.3.1 Impact Assessment

Based on the preliminary engineering design, Figure 4.2 outlines the three required water course crossing points (SC1, SC2, SC3). Table 4.1 and Table 4.2 outline the positional coordinates and spatial extents. Two of the three are existing crossings (requiring significant upgrades) and one additional stream crossing location. Figure 4.3 highlights two existing crossings (A, B) which are proposed to be removed during site development.

Figure 4.2: Locations of watercourse crossings (SC1, SC2, SC3).

Table 4.1: Watercourse crossing positional location.

Stream Crossing Point	Functional Requirement	Crossing Point (NZTM)
SC1	Required to create access road to western side of property but offset from wetland and forest remanent	1803591.021 5792674.945
SC2	Required in that location to avoid two wetland areas	1804077.785 5792688.941
SC3	Realigned as required to provide main accessway off State highway but also avoid sensitive wetland, pond, and watercourse	1804161.236 5792666.278

Table 4.2: Indicative watercourse crossing size details[46]

Stream Crossing Point	Culvert Length	Culvert width	Culvert area over stream bed	Upstream Apron length	Upstream Apron Width	Upstream Apron Area	Downstream Apron length	Downstream Apron Width	Downstream Apron Area
SC1	19 m	3 m	76 m^2	3 m	3 m	9 m^2	3 m	9 m	9 m^2
SC2	19 m	3 m	76 m^2	3 m	3 m	9 m^2	3 m	9 m	9 m^2
SC3	19 m	3 m	76 m^2	3 m	3 m	9 m^2	3 m	9 m	9 m^2

Figure 4.3: Existing watercourse crossings proposed for removal as part of the site development

The combined 273 m^2 (76 m^2 x 3 plus 18 m^2 for the upstream and downstream aprons) and 75 m (19 m x 3 plus 18 metres length for the upstream and downstream aprons) of permanently modified stream area and stream bank length loss for SC1-SC3 was assessed as having a very

[46] Note: The culvert lengths and auxiliary structures sizes are preliminary estimates and considered very conservative until such time as detailed design is undertaken as part of catchment analysis. i.e., culverts may meet the permitted standard size requirements in the NES-F and not require resource consent after detailed design. This report does not consider resource consent requirements for culverts under the Regional Natural Resources Plan.

high magnitude of impact on existing stream bed and bank habitat at the impact sites, due to the major alteration of a key element/feature of the existing baseline condition (natural stream alignment and bed).

The post-development character, composition and attributes will temporarily change with a shift from natural (albeit highly degraded) stream bed to an artificial structure, until such time as sediment and gravels migrate through the structures and a naturalised stream substrate is formed. However, it is recognised that groundwater-stream flow connectivity, floodplain engagement and organic inputs from the riparian margin will be permanently lost from the culvert stream crossing.

The very high magnitude of impact of stream bed loss and stream length is expected to have a moderate overall level of effect on the existing low ecological values, with respect to stream habitat at the three impact sites[1].

4.3.2 Proposed Ecological Management Measures and Reassessment

In accordance with the effects management hierarchy under the National Policy Statement for Freshwater (NES-F 2021) it is considered aquatic offsetting[47] should be applied, as the preferred measures of avoidance and minimisation cannot be undertaken in this case.

It is recommended the aquatic offsets includes restoration and enhancement actions within the subdivision site. This includes areas immediately upstream and downstream of each proposed stream crossing point, and is recommended to meet the following criteria:

- Are located as close as possible to the impact site.
- Be as close to 'like-for-like' with respect to the type of freshwater systems affected, in this case the immediate adjacent SC1-SC3.
- Achieve no net loss[1], or preferably a net gain[1], in natural ecological values, as per guidance in [48] [49].
- Select an ecological currency for the biodiversity to be categorised and exchanged (in this case area and stream bank length has been used as the ecological currency), as no 'at risk' or 'threatened' species or habitats exist at the impact sites. It is recognised that this aquatic offset requires regulatory input to ensure compliance, such as condition of consent over the duration of the activity at the impact and offset site [50].
- Demonstrating additionality on how the biodiversity gains will be achieved. This is important to achieve outcomes above and beyond what would have occurred if the aquatic offset had not taken place.

In order to adequately offset any unknown adverse impacts to the central water courses bed habitat area and stream bank loss, as well as known factors such as time lag for revegetation establishment, a conservative approach is recommended. A 1:2 ratio of stream area and stream bank length loss to stream restoration is recommended. Therefore, a total of 546 m^2 of stream

[47] See the NPS-FM 2020 text for legal definitions of terms.

[48] Ministry for the Environment 2014 Guidance on Good Practice Biodiversity Offsetting in New Zealand.

[49] Maseyk, F., Ussher, G., Kessel, G., Christensen, M and Brown, M (2018) Biodiversity Offsetting under the Resource Management Act- A guidance document. Prepared for the Biodiversity Working Group on behalf of the BioManagers Group.

[50] Brown, M.A., Clarkson, B.D, Stephens, R.T and Barton, B.J. (2013) Compensating for Ecological Harm – the state of play in New Zealand, New Zealand Journal of Ecology, Published online: 7 November 2013

area and 150 m of stream bank restoration is required. This approach is consistent with other offset ratios recommended in New Zealand from stream bed and bank loss [51].

The current masterplan proposes stream and wetland restoration and revegetation across the site which will adequately minimise and offset the proposed stream loss and result in no net loss of biodiversity values.

This will achieve a net gain in ecological values of the impacted Mangapiko Stream and associated wetlands. Meaning the measurable positive effects of biodiversity restoration and enhancement planting will exceed the point of no net loss. The aquatic offsetting proposed will result in no residual adverse effects that are more than minor. Therefore, in accordance with the effects management hierarchy, aquatic compensation is not required as the residual ecological impacts will be adequately offset.

Further, ecological outcomes will be integrated into the engineering design of the culverts, to remediate adverse impacts on stream ecology through rehabilitation. The culverts will be designed to a specification that will facilitate long-term "bedding in". It is expected that the base of the culverts will infill with sediments and other substrates, such as gravels and cobbles within 2-3 months, returning to a somewhat natural state and thereafter providing habitat for indigenous freshwater macroinvertebrates and fish. The physical habitat and basic ecological functions of the stream will be rehabilitated through the stream simulation design of the culverts[52],

Ecological Impact Assessment Summary

Following the remediation measure of integrating ecological outcomes into engineering design, and the minimisation and aquatic offsetting measures of restoration riparian and wetland planting within the subdivision, it is expected the streambed and stream bank loss will have a low magnitude of impact on the existing low stream habitat values at the three stream impact sites. Based on the EIANZ guidelines (criteria for describing level of effects[1]) this results in an overall very low level of effect.

Although the works will result in a minor shift away from existing baseline conditions, the underlying character, composition and attributes of the streambeds will be improved compared to pre-development circumstances following application of the ecological management package (criteria for describing magnitude of effect[1]).

4.4 Freshwater Ecology: Earthworks

4.4.1 Impact Assessment

An assessment of potential effects based on preliminary engineering design has been completed. The potential effects of earthworks from a residential development are most likely to occur during construction phases. Effects from construction mostly surround the mobilisation of dust and sediment. Sedimentation could occur in or near the wider stream environment if sediments were to discharge from earthwork activities.

Unmanaged, sediment input can adversely impact downstream freshwater quality, hydrodynamics, and habitat. Suspended sediments increase water turbidity and can adversely impact native

[51] Battersby, P., (2020) Milldale Argent Lane Extension Ecological Assessment of Effects, Epoch Ecology, report prepared for Mott MacDonald/Fulton Hogan

[52] Franklin, P., Gee, E., Baker, C & Bowie, S (2018) New Zealand Fish Passage Guidelines. NIWA Client Report 2018019HN

predatory fish behaviour and vigour by restricting visibility and hunting success[53]. Moreover, sediment loading can lead to fish mortality through gill clogging. Subsequent reduction of light from suspended particles can also result in reduced aquatic plant photosynthesis, and in turn can lower dissolved oxygen concentration in the waterbody[53].

The Mangapiko Stream is the receiving environment for the central watercourse and the unnamed watercourses onsite and is within the Waipā catchment. Although the area of impact is 1km upstream of the Mangapiko Stream, unmanaged temporary works could potentially influence a length of downstream habitat.

The implications of unmanaged sedimentation for the Waipā catchment are as follows:

- Ribbon development[54] and intensification extending from town centres causes a loss of natural soil resource that takes hundreds of years to create and associated loss of high-quality agricultural land and land use options.
- Impacts on water quality and the habitats of taonga species in the catchment.
- Potential negative effects overall on indigenous biodiversity, river recreation and flood risks, as well as downstream and neighbouring environments.

An uncontrolled sediment or contaminant discharge to the stream during earthworks could have a Moderate magnitude of temporary ecological effect on the existing character of the stream, due to the alteration of a key element of the existing baseline condition (Appendix F).

4.4.2 Proposed Ecological Management and Reassessment

An ESCP should be prepared as a part of the resource consent application. This is a key mitigation measure to prevent erosion, sedimentation and contaminant discharges occurring during earthworks. The ESCP is to be approved by the WRC and contain measures such as stormwater management, in accordance with industry best practice. The document should align with the WRC Erosion and Sediment Control Guidelines.

The ESCP should describe how planning and design of the proposed earthworks has been undertaken to ensure all potential adverse environmental effects are mitigated. This will be achieved by timing and sequencing of the earthwork's activities with the inclusion of specifically designed erosion and sediment control devices. The ESCP should consider the following methods of compliance and mitigation of impacts on the environment:

- While undergoing works on or near the modified watercourse(s) on site use clean water diversion channels to intercept water during earthworks, so it bypasses all open areas of earthworks, and discharges directly downstream of the site. Thus, reducing the volume of surface runoff requiring treatment.
- Sediment retention ponds should be installed (or investigate using the existing ponds utilised on site) to capture sediment laden runoff and may be used in conjunction or alternatively to watercourse diversion channels. Ponds should be regularly inspected for seepage and if required sediment removed as to maintain treatment capacity.

[53] Cavanagh, J.E., Hogsden, K.L., & Harding, J.S. (2014). Effects of suspended sediment on freshwater fish. Report prepared for West Coast Regional Council. Envirolink Advice Grant 1445- WCRC129.
[54] The term 'ribbon development' refers to a line of houses built along existing highways (or similar linear barriers).

- Disturbed soil should be stabilised as soon as practicable after construction with either biocore and/or grass seed and no unstabilised surface shall be left if heavy rainfall is forecast.
- Rainfall triggered flocculation treatment systems should be established on the development site to treat sediment laden runoff prior to discharge from the site.
- Avoid sensitive periods for works, such as winter when high water tables in and around the identified wetlands may entrain more sediment runoff into adjacent waterways.

Following the mitigation measure of finalising and adhering to the ESCP, the magnitude of impact and overall level of effect of earthworks on Low existing stream habitat ecological values would be Very Low (Appendix F).

4.5 Freshwater Ecology: Stormwater

4.5.1 Impact Assessment

The private plan change involves changing the land use from rural (pastoral agricultural) to residential. This change in land use will influence the dynamics of stormwater at the site. For example, rural contaminants are typically dominated by nutrients (e.g., nitrogen and phosphorus as recorded in Section 3.2), whereas residential contaminants potentially include a range of heavy metal (e.g., zinc) and hydrocarbon contaminants (e.g., road derived sediments).

The change of land use away from rural activities may cause potential positive ecological effects to the site's aquatic resources. The current agricultural land use has resulted in degraded water quality at the site along with impacts to soil resources from pugging and trampling on wetland areas. With the change in land use, its predicted that nutrient inputs from animal effluent and fertiliser application will likely reduce the nutrient loads to the already degraded watercourses and wetland environments.

At present, WRC monitoring data indicates rising trends in nitrogen and phosphorus in the Waipā Catchment, which is a priority area for nutrient load reduction. The change in land use away from intensive agriculture is then assessed as a positive for the Mangapiko Stream and the downstream aquatic environment.

Additionally, increased urban intensification increases the quantity of stormwater and changes the overall hydrological regime (including change to site point sources inputs). In order to understand the process of runoff movement through a property, the source, pathway, and receiving environment should be considered. These processes cause impacts related to the increased stormwater runoff from those surfaces, including:

- Reduced or increased base flow to streams.
- Increased flow rates, velocities and volumes of stormwater runoff, which can cause degradation of stream channel physical structure (reduction of bank stability, structural constraints [stream crossings, channel reinforcement], incised channels and reduced connectivity with the floodplain).

Overall, stormwater impacts were assessed as having a low magnitude of ecological impact on existing stream bed habitat, with only a minor shift and any alternation will be discernible from the baseline condition, however, ecological minimisation measures are still proposed.

4.5.2 Proposed Ecological Management and Reassessment

A Stormwater Management Plan (SMP) should be prepared prior to works commencing. The SMP for the site will detail the methods of compliance and mitigation required for stormwater discharges within the site and describe how site design ensures all potential adverse environmental effects of stormwater are avoided, remedied or minimised.

The SMP should consider the following methods of compliance and mitigation of stormwater impacts on the environment:

- Investigate using the existing on-site manmade ponds as stormwater storage and treatment devices. During and after construction phases, the ponds will provide increased residence time and promote the settling of sediment. Detention ponds should consider both the detention of peak flow, and extended detention for downstream erosion protection. Consider treating dissolved nutrient fractions (e.g., dissolved reactive phosphorus [DRP] also referred to as filterable reactive phosphorus [FRP]).
- Model spring locations and flow rates in order to calculate flood storage capacity at the site.
- Stormwater treatment design should provide for volume control increases for the 2 and 10-year ARI[55] events. Additionally, where there is downstream flooding of habitable structures, ensure post-development peak discharge for the 100-year ARI event does not exceed 80% of the pre-development peak discharge for the 100-year ARI event.
- Utilize non-structural methods (e.g., riparian buffers, implementation programme for bank stability, vegetation preservation, and revegetation) in order to adequately offset any unknown adverse impacts due to stream loss. Suggest planting indigenous vegetation suitable for stormwater treatment, such as sourcing ecological importance local wetland species.
- Daylighting[56] or recontouring the current watercourse, which will increase the flood plain connectivity and assist in conveyance of flood flows through the site. Maximum daylighting of streams is supported by WRC.
- Consider active management and monitoring of stormwater in real time using turbidity sensors).

Aside from the SMP, low impact design should be incorporated into the subdivision design so that existing ecological features of the site and restoration of historical ecosystem function are considered, such as creation of watercourse- wetland- forest ecological corridors through the site.

Following the outlined mitigation measures, the magnitude of impact and overall level of effect of stormwater on low existing stream habitat ecological values would be very low (Appendix F).

4.6 Freshwater Ecology: Native Fish and Macroinvertebrates

4.6.1 Impact Assessment

Potential impacts of the proposed stream work on freshwater fish and macroinvertebrates were assessed. The culvert stream crossings will be designed to allow for freshwater fish passage. The stream works are unlikely to result in the loss of any significant fish spawning habitat and the proposed stream daylighting, stormwater design, and wetland restoration will provide increased

[55] ARI = Average Recurrence Interval

[56] Stream daylighting means restoring streams to a more natural state. The result is improved stormwater flows from flood plain connectivity, fish spawning habitat, organic inputs and pollutant removal.

habitat availability for native fish and macroinvertebrates. However, any unmanaged stream works could inadvertently result in the mortality of indigenous fish and stream invertebrates and could temporarily obstruct fish passage during stream works. Therefore, onsite management during all stream works including restoration activities is required.

Based on the draft stream enhancement plan and cross sections drawings (BTW Company Drawings 210321-07) approximately 450 metres of the central water course will be recontoured by physical works. The works will be undertaken above the normal baseflow height so no works will be undertaken in flowing water. An excavator will be reused to shape the banks as per the proposed cross sections and the contoured slopes will be stabilised immediately by geotextile cloth prior to revegetation, as outlined in the Draft Riparian and Waterways Protection and Enhancement Plan.

Overall, the level of ecological impacts on freshwater fish values is Low based on the Moderate magnitude of effects from earth and stream works (Roper-Lindsay et al 2018). Potential instream earthworks from the stream crossings will require the relocation of native fish prior to earthworks, and the specific fish capture protocols will depend on construction methodology and best practise at the time of construction.

Furthermore, the site works are likely to illicit a localised Moderate magnitude of impact on the Low value macroinvertebrate communities present and will result in a Low to Very Low overall level of ecological effect. However, it is expected that this effect will be temporary, and that the population will recover after completion of the development.

4.6.2 Proposed Ecological Management and Reassessment

The potential adverse effects of the works and the development on freshwater fish and macroinvertebrates are expected to be addressed through the engineering design for stream crossing culverts, stormwater treatment, the site erosion sediment control plan and a site-specific Fish Management Plan (FMP).

The FMP should cover the maintenance of fish passage during construction, fish trapping, and transfer during the construction and stream restoration activities. Biosecurity measures will also need to be considered in the FMP, and it’s recommended the FMP be developed with tangata whenua and Waikato Regional Council Freshwater Ecologists.

Following the implementation of the FMP, the proposed stream works are expected to result in an overall Very Low level of effect on freshwater fish and macroinvertebrates.

5 TERRESTRIAL ECOLOGY

5.1.1 Impact Assessment

As outlined in Section 3, the majority of terrestrial ecology units and habitats at the site were low valued introduced pasture and/or very low value introduced trees. The masterplan concept indicates all indigenous vegetation such as the kahikatea stand, wetland vegetation and the mature eucalyptus trees will be avoided, fenced and retired as part of the development.

It is however recognised that large areas of the site will be developed into housing, roading, pathways, and other impervious surfaces. Therefore, it is expected that all the introduced trees (excluding mature eucalyptus) and vegetation will be disturbed, resulting in a high loss of introduced terrestrial flora, and subsequent loss of soil biology and physio-chemical properties. It's also recognised that although all the large trees will remain as a conservative approach to protecting bat roosts, the change in land use could result in light impacts to feeding bats from the subdivision. The implication of light pollution should then be considered in the subdivision design, especially in the wetland and kahikatea stand.

Prior to mitigation, the magnitude of effect of the proposed development on existing terrestrial habitat is determined to be High. However, when considering the Moderate ecological value of terrestrial ecology on site, the overall effect remains High prior to mitigation (Appendix F).

5.1.2 Proposed Ecological Management and Reassessment

It is recommended that Weed and Pest Management be a consideration in a site wide Ecological Management Plan (EMP). The EMP will be the key document (post consent) for the site to outline management steps to avoid, minimise and remedying potential ecological impacts to terrestrial ecological values, such as steps to facilitate pest control, weed suppression, restoration of habitat for indigenous fauna, and ecological corridors between fragmented habitats (i.e., identified wetlands and the kahikatea stand).

The EMP should ensure there is no net loss of biodiversity in the long-term and should detail planting methodologies, lists and maps of plant species and planting densities, weed management protocols, and ongoing maintenance requirements.

Restoration of forest vegetation is likely to occur at the long-term timescale, with plant maturity of some species expected to take upwards of 25 years. The EMP plan and subdivision design should consider future management controls to ensure there are no potential or adverse ecological impacts to the high value fauna such as bats and/or potential herpetofauna habitat.

Following the avoidance strategies through the design process, remediation and ecological minimisation measures of finalising and implementing the aforementioned EMP, the long-term magnitude of effect is assessed as Positive and the overall level of effect a Net Gain (Appendix F).

5.2 Wetland Ecology

5.2.1 Impact Assessment

Indigenous wetland habitats and the species they contain have been drastically reduced in extent across the Waikato and Waipā region. It is estimated that wetland extent in the Waipā catchment was ~15,564 ha, with only 12% remaining (i.e., 1859 ha)[57].The remaining isolated remnants in the Waipā catchment are degraded and are particularly vulnerable to adverse effects from nutrient inputs, invasive weed plants and alteration to hydrology from historical drainage and agricultural development.

As describe in Section 3, a total of 10 fragmented wetlands ranging from 10.7 m^2 to 1105 m^2 with a total of 3,258 m^2 of wetland habitat has been identified and delineated at the site. The size, fragmentation and drainage of many of these remnant wetlands has resulted in pronounced 'edge' effects from weeds, increased light, wind and extremes of temperature and humidity. Additionally, the mesic organic peat soils surrounding the wetlands are degraded from livestock pugging.

Prior to the measures of avoiding all wetlands in the subdivision design, the magnitude of effect of the proposed development on existing wetland habitats is determined to be High. Despite the fragmentation of the wetlands, these ecosystems are of High ecological value because of the importance to site hydrology and national importance of wetlands[58]. Therefore, the overall level of ecological effect is High (Appendix F).

5.2.2 Proposed Ecological Management and Reassessment

The management of wetlands (and the interconnected stream watercourse) is important for the protection of natural ecological and biodiversity values, for the efficient passage of flood flows, and water quality. Overall, retaining the existing wetlands, connecting fragmented wetlands and enhancing riparian restoration around all watercourse is highly recommended.

The following avoidance, remedying and minimisation methods as per the NPS-FM effects management hierarchy are recommended:

- All wetlands are to be avoided and the site layout design amended to reflect this avoidance measure.
- An additional 10 m perimeter 'offset' around each wetland shall be surveyed as to create an exclusion area, which will be revegetated as outlined in the site EMP and the draft Riparian and Waterway Restoration and Enhancement Plan.
- Appropriate resource consents are obtained from WRC for water course diversion and works near any wetland.
- Access to the wetlands by people and machinery shall be prohibited both during and after construction, unless for wetland restoration efforts, as per the site EMP.
- Consider ecologically and hydrologically connecting the fragmented wetlands where possible through planting and avoiding development in these areas. This is a key remedial measure to enhance the wetlands across the site.
- Wetlands within the sub catchment should be enhanced through implementation of the site EMP, including creating more black mudfish habitat where possible resulting in biodiversity gains.
- Wetlands should be monitored over time to assess condition, functioning, and the effects of the new surrounding land use.

[57] Waikato Regional Council 2014. WRC 2014. Waipa Catchment Plan. Waikato Regional Council Technical Report 2014/33.

[58] Ministry for the Environment. (2022). Defining 'natural wetlands' and 'natural inland wetlands'. Guidance to support the interpretation of the National Policy Statement for Freshwater Management 2020 and the Resource Management (National Environmental Standards for Freshwater) Regulations 2020

- The wetland delineation assessment (Appendix C) should be referred to and updated where necessary.

Following the avoidance, remediation and minimisation measures of finalising and implementing the aforementioned EMP and enacting the recommendation in the draft Riparian and Waterway Restoration and Enhancement Plan, the long-term magnitude of effect will be Low, and will result in an overall level of positive ecological effect and/or Net Gain to biodiversity values in the Waipā Catchment (Appendix F).

5.3 Summary of Impact Assessment

The overall levels of ecological effect of the proposed activities were assessed based on the descriptions of existing ecological values provided in Section 3 and potential and actual impacts described in Section 4, without additional ecological management measures. Levels of effect were then reassessed, with recommended management measures considered.

A summary of the key values and criteria used to determine existing ecological values, magnitudes of effect and levels of effect are provided in Table 5.1, as adapted from the EIANZ EcIA Guidelines.

It should be noted that if the recommended mitigation measures are not implemented, the described ecological impact is considered at the 'without mitigation' level (see table 10, Roper-Lindsay et al., 2018[1]).

Table 5.1: Summary of Ecological Impact Assessment

Impact Area	Potential Impact Details	Ecological Value	Magnitude of Effect	Level of Effect (without ecological management)	Recommended Ecological Management	Level of Effect (with Ecological Management)
Stream Crossing Points	Permanent modification of 273 m^2 of stream bed and 75 m of stream length	Low	Very High	Moderate	Implement Fish Management Plan and integrated engineering design into culverts to ensure no further ecological impacts. The permanent modification will require aquatic offsetting at a 1:2 ratio, which will require 546 m^2 of stream habitat and 150 m of stream length to be offset. The aquatic offsets will be determined as per the recommended Ecological Management Plan once consent is approved. Effects Management Hierarchy-Avoidance, Minimising and Offsetting.	Very Low

Impact Area	Potential Impact Details	Ecological Value	Magnitude of Effect	Level of Effect (without ecological management)	Recommended Ecological Management	Level of Effect (with Ecological Management)
Earthworks	Mobilisation of dust and generation of sediment runoff leading to water courses until the site has been stabilised. Construction may cause stream bed habitat loss, change in baseflow conditions	Low	Moderate	Low	Implement and follow ESCP, mitigate site flooding effects and provide effective passageway for aquatic organisms during construction. Avoid sensitive periods for works. Effects Management Hierarchy-Avoidance and Minimise	Very Low
Stormwater	Change in stormwater contaminant loads from diffuse agricultural inputs to point source inputs from residential land uses where contaminants are not yet quantifiable. Reduced baseflow, increased peak flows. Decrease in agricultural nutrient inputs is a positive impact.	Low	Moderate	Low	Investigate utilize existing manmade ponds as stormwater treatment. Model spring locations and flow rates. Provide controls for ARI events. Planting indigenous plants suitable for stormwater treatment Use of biological treatment devices to treat dissolved fractions (e.g., FRP), follow guidelines outlined in future ESCP and SMP, adaptive management of stormwater e.g., turbidity sensors. Effects Management Hierarchy-Avoidance, Remedy and Minimise	Very Low

Impact Area	Potential Impact Details	Ecological Value	Magnitude of Effect	Level of Effect (without ecological management)	Recommended Ecological Management	Level of Effect (with Ecological Management)
Freshwater fish	Temporary fish passage obstruction during stream works and bank recontouring. Sedimentation.	Low	Moderate	Low	Landscape and revegetation efforts as outlined in the draft Riparian and Waterway Restoration and Enhancement Plan and the recommended Ecological Management Plan (EMP) and Freshwater biosecurity controls during any works in or near waterways. Fish Management Plan (FMP). Effects Management Hierarchy-Avoidance and Minimise	Very Low
Freshwater macroinvertebrates	Macroinvertebrate mortality (temporary effect on population). Sedimentation and smothering, filling of interstitial spaces in stream bed.	Low	Moderate	Low	Natural replenishment of population. Site Ecological Management Plan (EMP) Effects Management Hierarchy-Avoidance, Remedy and Minimise	Very Low
Terrestrial ecology	Fragmentation causing edge effects (e.g., increases in temperature, weed invasion, noise and pollution). Roads and pavements increase removal or vegetation. Kahikatea stand and eucalyptus trees to be preserved but may be subject to the increased edge effects.	Moderate	High	Moderate	Prepare Ecological Management Plan (EMP)-once consent is granted to facilitate pest control, weed control, restoration, and mitigation of edge effects. Enact the recommendations in the draft Riparian and Waterway Restoration and Enhancement Plan Consideration of lighting impacts through subdivision design Effects Management Hierarchy-Avoidance, Remedy and Minimise	Net Gain

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Impact Area	Potential Impact Details	Ecological Value	Magnitude of Effect	Level of Effect (without ecological management)	Recommended Ecological Management	Level of Effect (with Ecological Management)
Wetlands	Further fragmentation and edge effects which can potentially alter hydrology and organic soil and increase invasive plant colonisation. Further loss of wetlands in the Waikato.	High	High	High	Avoid all wetlands when design site layout and limit access during and after construction. Add an additional 10 m around the perimeter of each wetland during construction. Consider ecologically and hydrologically connecting fragmented wetlands through planting and enhancement, with reference to a draft Riparian and Waterway Restoration and Enhancement Plan and the Ecological Management Plan. Monitor wetlands over time and ensure appropriate resource consents are obtained from WRC for diversion and works near or within wetlands. Based on the draft masterplan, there will be a 550% increase in the area of wetland habitat which will be retired, fenced and restored compared to the current intensive land use. It's assessed that this will be a positive ecological impact from the change in land use associated to the subdivision. Effects Management Hierarchy-Avoidance, Remedy and Minimise	Net Gain

▪ .

6 CONCLUSIONS

Te Awamutu Developments have proposed a development on 2025 Ōhaupō Road (Part Lot 1 DP 356454 and Lot 1 DPS 36696). This EcIA informs the master design process for the development as to provide supporting information for the Private Plan Change Request to the WDC. Importantly, the EcIA is a guide to inform future iterations of the masterplan and to ensure potential or actual ecological impacts are managed.

The following points summarise the main findings of this EcIA:

- The site is dominated by low or very low valued introduced pasture grasses, with the highest ecological values on the site associated with the 10 wetlands and the kahikatea SNA.
- Potential positive effects of the proposal, include enhanced habitat values and net ecological gains through protection and enhancement of wetlands, restoration of the water course and riparian margins.
- The draft masterplan encompasses the identified wetlands across the site, with none of the identified wetlands to be impacted by the proposed development. Based on the subdivision design the area of wetlands to be retired, fenced and enhanced will increase by 550% compared to the current land use at the site. It's assessed that this is the single greatest positive ecological impact from the proposal.
- Potential or actual adverse effects were assessed, such as impacts to freshwater ecological values from stormwater impacts, sedimentation from earthworks and stream habitat changes from culverted stream crossings and bank recontouring.
- Overall levels of ecological effect of the proposed activities were determined to be Very Low, following ecological management, through low impact design, avoidance and minimisation measure and aquatic ecological offsetting.

7 RECOMMENDATIONS

To manage these actual and potential adverse impacts, the following are recommended:

- Implement a Council approved ESCP and SMP, to mitigate sediment-laden flows and other contaminants from entering the watercourses and wetland during the works, and adhering to the proposed waterway, wetland and riparian enhancements in accordance with ecological advice.
- Development of a site Ecological Management Plan (EMP) after consents are granted, including enacting the recommendations in the draft Riparian and Waterway Restoration and Enhancement Plan as part of detailed design and can be addressed as a resource consent condition. This should include the planting of indigenous plants suitable for stormwater treatment in swales and/or those that provide biofiltration[59,60].
- Adaptive management of stormwater, such as monitoring conditions on consent. This may include the use of turbidity sensor measurements for ongoing monitoring.
- Prepare an FMP, to manage fish passage and salvage during any stream works, which also includes pest fish management. The FMP shall be developed in conjunction with WRC and tangata whenua.
- Ensure site scheme layout avoids wetlands and restricts access during and after construction. Consider ecologically and hydrologically connecting fragmented wetlands through planting and enhancement, with reference to the draft Riparian and Waterway Restoration and Enhancement Plan.

This EcIA has been prepared based on the proposed activities and works, as described in Section 1. It is recommended that a supplementary ecological statement is issued, or this report updated, as the detailed design and construction methodology is amended to ensure that the recommendations provided within the EcIA remain applicable and relevant to the proposed activities and impacts.

[59] Blecken, G. T., Zinger, Y., Deletić, A., Fletcher, T. D., & Viklander, M. (2009). Influence of intermittent wetting and drying conditions on heavy metal removal by stormwater biofilters. Water research, 43(18), 4590-4598.

[60] Read, J., Wevill, T., Fletcher, T., & Deletic, A. (2008). Variation among plant species in pollutant removal from stormwater in biofiltration systems. Water research, 42(4-5), 893-902

APPENDIX A DRAFT SCHEME PLAN

For Discussion Only

Notes.
1. This concept masterplan is for discussion purposes only.
2. Elements such as pathways, proposed tree plantings, and the open space around the care facilities and clubhouse are not final and are subject to further design resolution.
3. Transport review needed on road alignments.

2050 Ohaupo Road
Concept Masterplan
Overall Site Sketch

Scale. 1:3,000 at A3
Date. 27/08/2022

Status. For Discussion
Sheet. NA

B&A
Urban & Environmental

I:\Jobs\13000-13999 General Jobs\19517 2025 Ohaupo Rd Masterplan

APPENDIX B SUMMARY OF GENERAL SITE OBSERVATIONS AND ECOLOGICAL FEATURES

Ecological components and/or features related to the site are listed in Table B 1 below.

Table B 1: Conspicuous Ecological features of site

Ecological feature	Type/species	Location
Terrestrial vegetation	▪ Mixture of pastoral grass and weed species. ▪ Native tree species including kahikatea ▪ Exotic tree species including eucalyptus, poplars	▪ Pasture on site generally consisting of introduced high producing grasslands ▪ Kahikatea stand approximately 1 km2 in Eastern corner of site ▪ Eucalyptus trees located adjacent to Kahikatea stand, poplars and other deciduous trees line the central watercourse and surround ponds. ▪ Area of deciduous trees along waterway discharging into stream.
Macrophytes and riparian vegetation	▪ Cat grass (Dactylis glomerata) (Introduced) ▪ Calla lily (Zantedeschia aethiopica) (Introduced) ▪ Flowering dogwood (Cornus kousa) (Introduced) ▪ **Harakeke** (Phormium tenax) (Native) ▪ Watercress (Nasturtium officinale) (Introduced) ▪ Parry's rush (Juncus parryi) (Introduced) ▪ Poplars, aspens, cottonwoods (Populus) (Introduced) ▪ Yorkshire fog (Holcus lanatus) (Introduced) ▪ Creeping buttercup (Ranunculus repens) (Introduced) ▪ **Great soft rush** (Juncus pallidus) (Native) ▪ Chickweed (Stellaria media) (Introduced) ▪ Knotgrass (Paspalum distichum) (Introduced) ▪ White clover (Trifolium repens) (Introduced) ▪ **Water pepper** (Persicaria hydropiper) (Native) ▪ **Makura/sedge** (Carex secta) (Endemic) ▪ Dock (Rumex obustifolius) (Introduced) ▪ Jointed rush (Juncus articulates) (Introduced)	Found within wetland areas and lining the central watercourse

▪ Emboldened species are native or indigenous to New Zealand

APPENDIX C WETLAND DELINEATION MEMO

To:	Levin Da Costa (Director, Ultimate Holdings Ltd)				
Copy:	Dean Sandwell (Team Leader Environment- Waikato, BTW Company Ltd); Angela Smith (Senior Environmental Scientist, BTW Company Ltd); Greg Larkin (Senior Environmental Scientist/Ecologist, BTW Company Ltd)				
From:	Alice Wheatley-Wilson (Graduate Environmental Scientist, BTW Company Ltd)				
Date:	29th June 2022	**BTW Job Number:**	211365	**Client Reference**	2025 Ohaupo Road

Subject: 2025 Ohaupo Road – Wetland Delineation Assessment

OVERVIEW

Ultimate Holdings Ltd (the client) has engaged BTW Company Limited (BTW) to assess the habitat within the subject site indicated in Figure 1, which has been identified as supporting potential wetland habitat. The subject site is positioned within the Waipa Stream catchment, North of Te Awamutu, Waikato. The total site area is approximately 25.78 Ha and comprised of two lots, 211365, and is being investigated by the client for a proposed subdivision. Potential wetland habitats were identified in the western end of the site during a previous preliminary site assessment in December 2021, with further assessment and delineation required[1].

Earthworks are required to enable the proposed subdivision. These earthworks may include land contouring and development on or near the adjacent potential wetland areas. Additionally, these potential earthworks inform and facilitate the anticipated Private Plan Change. A wetland habitat assessment under the National Policy Statement for Freshwater Management 2020 (NPS-FM 2020) was therefore required. Earthworks within a natural 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 wetland and does not have another status under any of regulations 38 to 51 (Clause 53(1), NES-FW). Further, earthworks within, or within a 10 m setback from, a natural wetland is a non-complying activity (Clause 51(b), NES-FW) and would require resource consent. The discharge of water within 100 m of any natural wetlands would also need to be considered in any stormwater design associated with the subdivision. The impacts and change in stormwater and overland flow that would result from the proposed subdivision have not been assessed in this memo and will require further assessment by a suitably qualified hydrologist or stormwater engineer.

[1] Preliminary Site Investigation (PSI) at 2025 Ohaupo, Te Awamutu (2021). BTW Company Ltd.

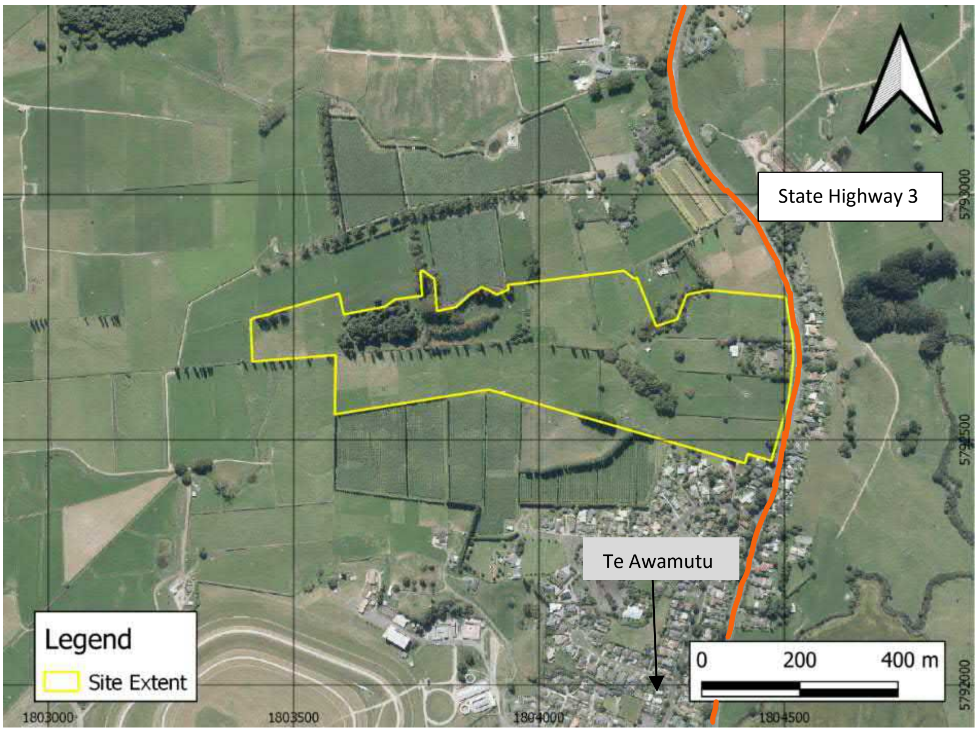

Figure 1: Site overview and extents

Scope of works

1. Identify and characterise wetlands in the context of the surrounding environment using national methods for delineating wetlands on site under the NPS-FM 2020 and undertake a risk assessment.

The scope of works included the following:

- Site visit, including vegetation identification within the subject site and soil assessment.
- Assessment of habitat within the subject site against wetland definitions set out in the following documents:
  - Resource Management Act 1991 (RMA)
  - NPS-FM 2020
- Wetland delineation assessment within the subject site in accordance with the following protocols:
  - Wetland delineation protocols 2020[2]
  - Wetland delineation hydrology tool for Aotearoa New Zealand[3]
  - Hydric soils[4] – field identification guide[5]

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[2] Ministry for the Environment (2020). ***Wetland delineation protocols.*** Published in August 2020 by the Ministry for the Environment. Publication number ME 1515. Wellington: Ministry for the Environment.

[3] Ministry for the Environment (2021). ***Wetland delineation hydrology tool for Aotearoa New Zealand.*** Published July 2021 by the Ministry for the Environment. Publication number ME 1575. Wellington: Ministry for the Environment.

[4] 'Hydric soils' is a general term for soils that are poorly or very poorly drained and have a water table above, at, or near the surface long enough during the growing season to develop anaerobic conditions in the upper layers.

[5] Fraser, S., Singleton, P., & Clarkson, B. (2018). ***Hydric soils – field identification guide***. Contract Report: LC3233. Prepared for Tasman District Council.

— A vegetation tool for wetland delineation in New Zealand[6]

Wetland Definitions

The following wetland definitions are currently used within New Zealand:

- The ***Resource Management Act 1991*** defines wetlands as including *"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"*.
- The following, more rigorous, wetland definitions are provided in Section 3.21 of the NPS-FM 2020:

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

  (a) a wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore, an existing or former natural wetland); or

  (b) a geothermal wetland; or

  (c) any area of improved pasture that, at the commencement date, is dominated by (that is more than 50% of) exotic pasture species and is subject to temporary rain-derived water pooling

  Natural inland wetland means a natural wetland that is not in the coastal marine area.

- ***Hydrophytes (hydrophytic vegetation) are plant species capable of growing in soils that are permanently or intermittently saturated with water during the growing season. The hydrophyte categories (wetland indicator status ratings: Clarkson 2013 and subsequent updates) are:***

  — ***Obligate (OBL): occurs almost always in wetlands (estimated probability >99% in wetlands)***

  — ***Facultative Wetland (FACW): occurs usually in wetlands (67–99%)***

  — ***Facultative (FAC): equally likely to occur in wetlands or non-wetlands (34–66%)***

  — ***Facultative Upland (FACU): occurs occasionally in wetlands (1–33%)***

  — ***Upland (UPL): rarely occurs in wetlands (****<1%), almost always in 'uplands' (non-**wetlands)***

Proposed changes to definitions

An exposure draft of the proposed changes to the NPS-FM[7] and NES-F[8] (including wetland regulations) has been released to show the amendments to wetland provisions in response to feedback on the managing our wetlands consultation process (2021)[9]. The proposals consulted on were clarifications to the definition of a 'natural wetland', consent pathways for additional sectors, including subdivisions, refinements to the restoration policies, and recognition of maintenance and biosecurity activities.

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[6] Clarkson, B. (2013). ***A vegetation tool for wetland delineation in New Zealand***. Prepared by Landcare Research Contract for Meridian Energy Limited. Landcare Research Contract Report LC1793.

[7] Exposure draft of amendments to the National Policy Statement for Freshwater Management 2020. DOI: https://consult.environment.govt.nz/freshwater/npsfm-and-nesf-exposure-draft/user_uploads/exposure-draft-changes-to-npsfm-2020.pdf

[8] Exposure draft of changes to the National Environmental Standards for Freshwater 2020. DOI: https://consult.environment.govt.nz/freshwater/npsfm-and-nesf-exposure-draft/user_uploads/exposure-draft-changes-to-rm-nesf-regulations-2020.pdf

[9] For background and further detail refer to: Managing our Wetlands: Policy rationale for exposure draft amendments 2022. DOI: https://environment.govt.nz/assets/publications/managing-our-wetlands-policy-rationale-exposure-draft-amendments-31May2022.pdf

Part c of the proposed new wetland definition excludes:

(c) any area of pasture that has more than 50 percent ground cover comprising exotic pasture species or exotic species associated with pasture.

The intention of this change, which excludes the “and is subject to temporary rain derived water pooling” clause, is to better acknowledge the original intent that wet pasture areas, even if they were once ‘natural wetlands’, are now highly modified environments and should be able to continue their current use or be able to shift in land use.

SITE DESCRIPTION AND GENERAL OBSERVATIONS

A site visit was undertaken by a suitably qualified and experienced ecologist from BTW Company on 26th May 2022, under fine weather conditions. Vegetation, soil and hydrologic conditions appeared to be normal for this time of year.

The mean monthly rainfall between 1981 and 2010 for Hamilton for February, March and April are 68.7, 79.4, and 80.3 mm, respectively[10]. The total rainfall at the nearest WRC rainfall monitoring site (Bartons Corner Rd Bridge) for February, March, and April 2022 were 93, 57, and 10.5 mm[11]. Dry conditions preceded the site visit. The MfE (2021) guidelines recommend that site visits should not be undertaken within two weeks of an extreme weather event. Rainfall recorded at the WRC Barton’s Corner Bridge rainfall monitoring stations within two weeks of the site visit were considered normal. The most recent rainfall event prior to the site visit was recorded at 3.5 mm (daily total) on 23rd May 2022, which is not considered to be an extreme weather event. Given that “normal conditions” were present at the time of the site visit, the MfE protocols and their assumptions can be applied to the subject site.

The potential wetland habitats are what remains of the historic marsh that once extended across the low elevation lowlands of Te Awamutu, bordering the Mangapiko stream.The subject site is situated in the middle of the Waipa catchment in Hamilton, Waikato. Thirteen putative wetland areas contained within the site (Ohaupo_WL1–13; Figure 2) were identified and assessed in the field. The marshlands are visible on-site in 1943 historic imagery[12]. The site’s central drain discharges in the west of the property into a tributary of the Mangapiko Stream, which eventually discharges into the Waipa River at Pirongia (Figure 2). These wetlands are the main source feeders for the unknown tributary. The survey extent terminated at the property boundary; any wetland boundaries may therefore extend onto neighbouring properties.

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[10] NIWA (2022)/ Mean monthly rainfall (mm). Retrieved from: https://niwa.co.nz/education-and-training/schools/resoures/climate/meanrain on 3 June 2022.

[11] Waikato Regional Council (2022). Puniu River – Barton’s Corner Road Bridge – Rainfall. Retrieved from: waikatoregion.govt.nz/environment/envirohub/environmental-maps-and-data/station/41893/RF?dt=Rainfall on 2 ne 2022.

[12] Appendix B. Preliminary Site Investigation (PSI) at 2025 Ohaupo, Te Awamutu (2021). BTW Company Ltd.

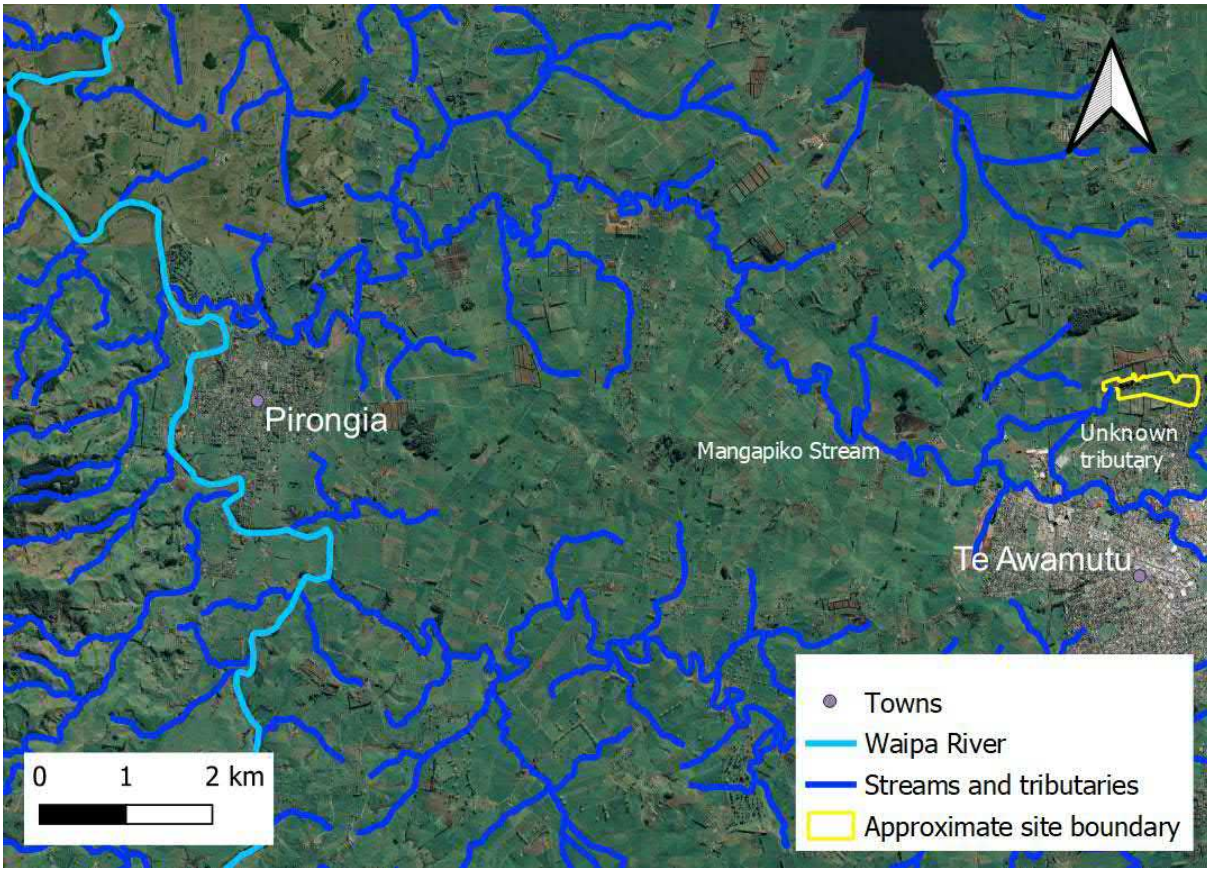

Figure 2: Map of river and stream centrelines within close proximity to the site (yellow outline)

The current land use at the site is pastoral agriculture[1]. Vegetation observed on-site include a kahikatea stand and three mature eucalyptus trees towards the western end of the site, poplars lining the central drain, and patches of exotic forest throughout the site. Pest vegetation species included woolly nightshade. Although the kahikatea stand is currently 1ha, the extent of this indigenous hardwood forest has decreased since 2002[13]. A significant area exists northwest of site in the catchment surrounding Lake Ngaroto.

WETLAND ASSESSMENT METHODOLOGY

The NPS-FM refers to the Ministry of the Environment (MfE) 2021 wetland delineation protocols in order to determine the status of wetlands. The delineation protocol set out in Figure 3 summarises the most recent wetland delineation guidance provided by MfE. This protocol builds on and integrates guidance included in preceding wetland delineation protocols[2]. This delineation protocol includes four key steps and uses the hydrophytic vegetation, hydric soils and wetland hydrology tools. The major vegetation type(s) at the site were mapped and assessed according to the methodology set out in Figure 3 to delineate the extent of any wetlands.

The protocol for determining the presence of hydrophytic vegetation is summarised in Figure 4[2]. The hydric soils and wetland hydrology tools referred to in Figure 3[5,3], respectively, are summarised in Figure 5 and Figure 6. Wetland hydrology (ponding and inundation) was determined using the Wetland Delineation Hydrology Tool which requires one primary indicator or two secondary indicators to be present to be considered consistent with wetland hydrology[14]. Representative vegetation plots were established within each major vegetation

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[13] Waikato Reginal Council Intramaps. DOI: https://waikatomaps.waikatoregion.govt.nz/Gallery/

[14] Ministry for the Environment. (2021). ***Wetland Delineation Hydrology Tool for Aotearoa New Zealand.*** Wellington: Ministry for the Environment.

type and assessed in accordance with these protocols, which is the standard onsite method used for small potential wetland areas (≤2 ha)[2].

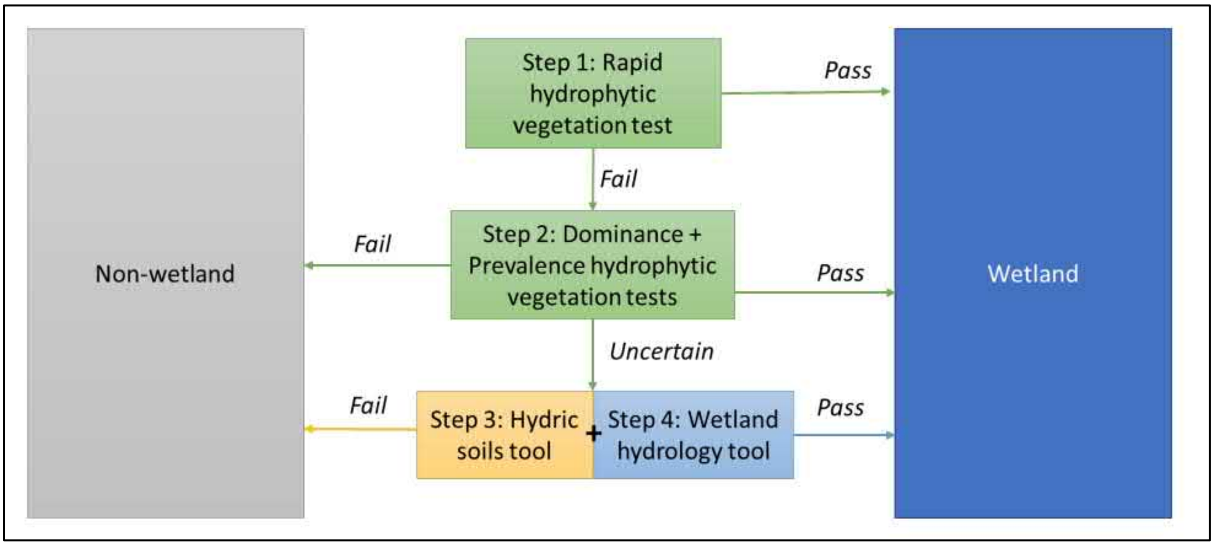

Figure 3: Four steps for delineating wetlands using the hydrophytic vegetation, hydric soils and wetland hydrology tools (retrieved from MfE, 2021).

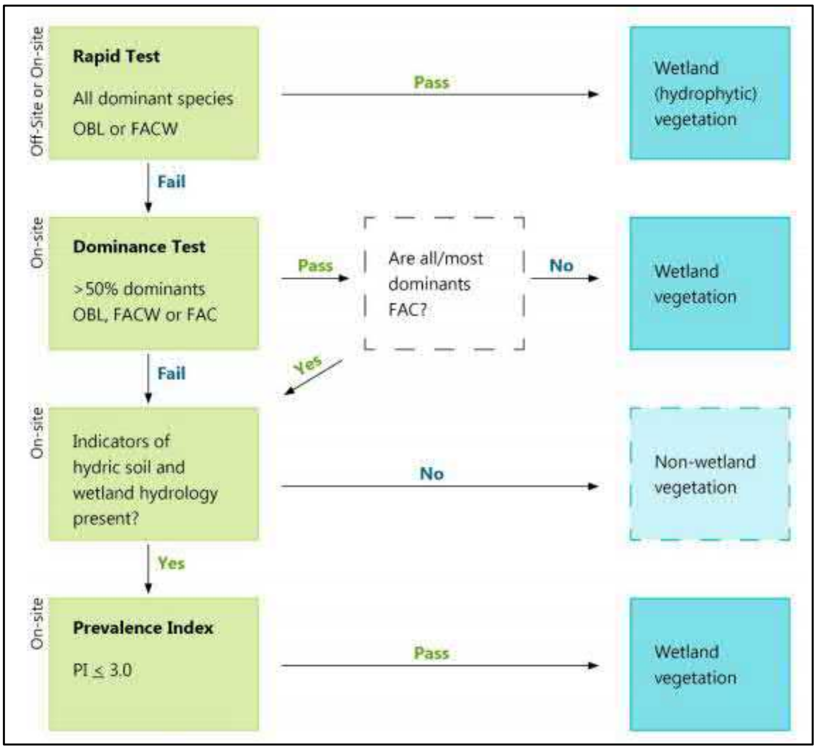

Figure 4: Flow chart of steps for hydrophytic (wetland) vegetation determination. Wetland indicator status abbreviations: FAC= facultative; FACW = facultative wetland; OBL = obligate wetland. Retrieved from the Wetland Delineation Protocols 2020 (MfE, 2020).

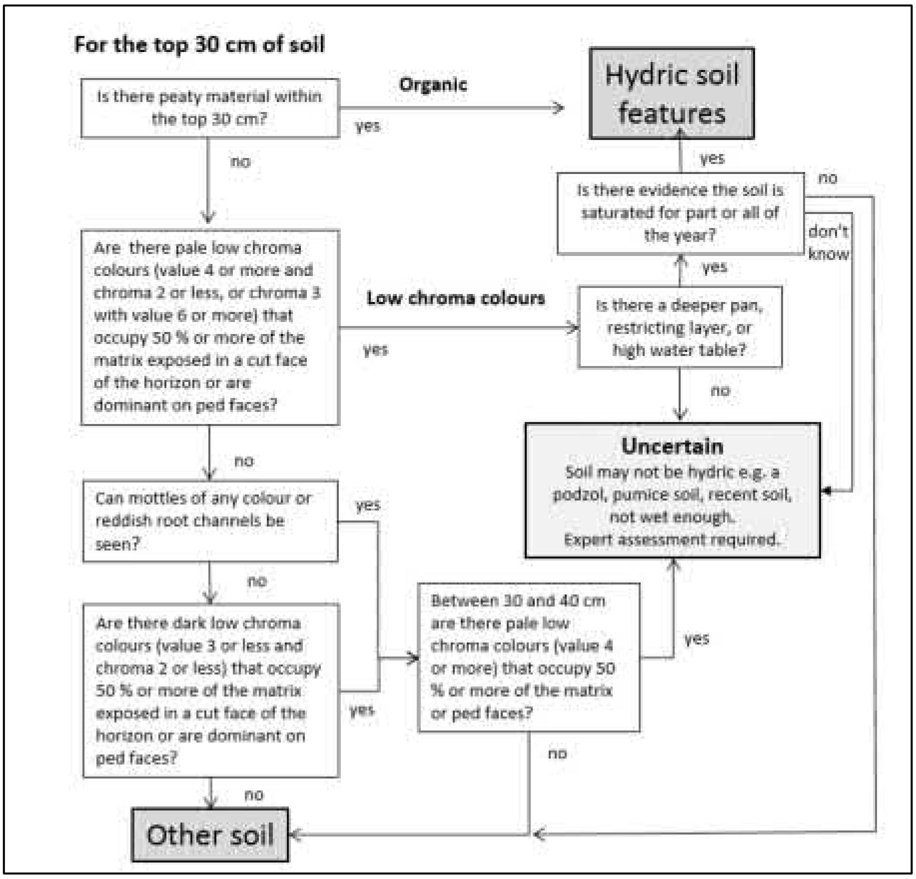

Figure 5: Simple key to identifying hydric soil features[5].

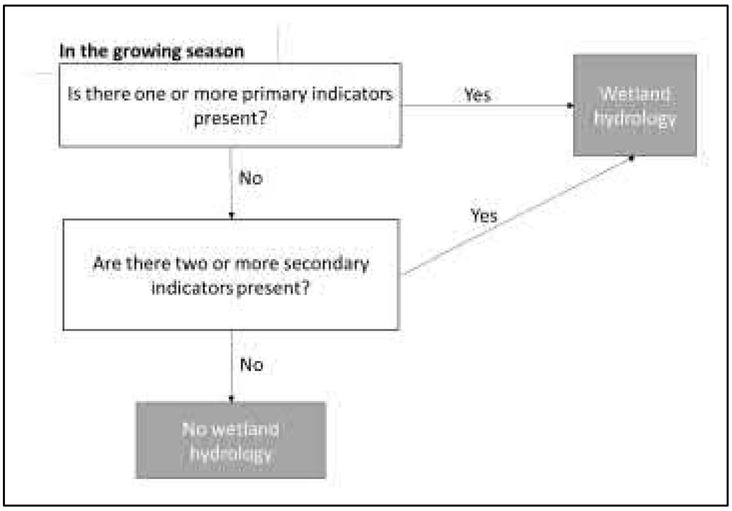

Figure 6: Simple key to describing wetland hydrology[3].

In accordance with the Wetland Delineation Protocols 2020[2], a conservative approach to delineation was taken. The in-field assessment involved a combination of observing obvious changes in vegetation (the first examples of wetland vegetation at the site), soil structure, and elevation/topography. The potential wetland habitats observed on site were divided into thirteen due to varying changes in these variables (e.g., hydrology, hydrophytic vegetation, hydric soils) within the assessment area. Each assessment was assigned a name (for example Ohaupo_WL1–13) and were grouped spatially for the wetland assessment (see below).

Vegetation on the boundary and 100 m downstream of the headwaters were not assessed under the Wetland Delineation Protocols (WDP's). This area is contained within the transitioning riverine landscape of the unnamed tributary, with the hydrology, soil structure, elevation/topography, and observed fauna supporting this assessment.

UAV Data Capture and Aerial Imagery Outputs

The vegetation units were demarcated using a combination of infield 'boots on the ground' and aerial imagery. Using UAV[15] technology, aerial imagery was captured including false colour composites (FCC), colour infrared (CIR), RGB[16], digital terrain model indices, and topographic indices.

The BTW UAV set-up included a high resolution RGB camera, multispectral cameras, externally mounted downwelling light sensor (DLS), and GPS modules. Multispectral sensors are used for a range of applications, such as fertiliser management, crop health mapping, weed detection, and water management and leak scouting. These sensors simultaneously capture red, green, blue, red-edge, and near-infrared (NIR) bands. The captured bands can be used to create indices and colour composites imagery for the detection of potential wetland areas. Topographic wetness and digital terrain indices are used to illustrate topographic controls on hydrological processes, while colour composite imagery outputs are used to reveal and enhance visibility of water features that are not immediately visible to the human eye. These indices and composite images provide data that highlights variations in ground cover, surface darkening, and vegetation growth influenced by differences in water presence variations and surface water features.

RESULTS

The putative wetlands were a network of fragmented remnants of the historical marsh. The Digital Terrain Model (Appendix A) and Topographical Wetland Index (TWI) imagery were assessed and highlighted the likely locations of water pooling. Indices suggest the potential wetlands were located in low-lying areas on site and each remnant was no larger than 250 m^2.

There are clear indications of drainage across the entire site, including attempts near some of the potential wetlands outlined in this study. For example, in Figure WL12 f) underground drainage piping originating from upslope and discharging into a nearby downslope drain is visible.

General Site Assessment

Vegetation plots were set up at ten of thirteen sites, with the exception of Ohaupo_WL10 (assessed as not a wetland in field) & WL13 (discovered through aerial imagery after the site investigation). The key vegetation types were grassland/rush land dominated by the facultative wetland species giant rush (***Juncus pallidus***) and mercer grass (***Paspalum distichum***) and the facultative species creeping buttercup (***Ranunculus repens***) and Yorkshire fog (***Holcus lanatus***). Some sites had more than 50% cover with exotic pasture species. As part of the proposed changes to wetland definitions, a pasture species list is set to be collated for aiding in "pasture species" classification, and areas with over 50% cover with pasture species will not be classified as wetlands. The pasture exclusion list states that creeping buttercup is not included as a pasture species, but Yorkshire fog is.

One of nine plots set up for assessing hydrophytic vegetation passed the rapid test for wetland delineation, six passed the dominance test, and eight plots passed the prevalence test (<3) according to MfE protocols. This is an expected result considering the site was historically marshland but has been subject to intensive drainage and has had a pastoral land use since.

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[15] Unmanned Aerial Vehicle.

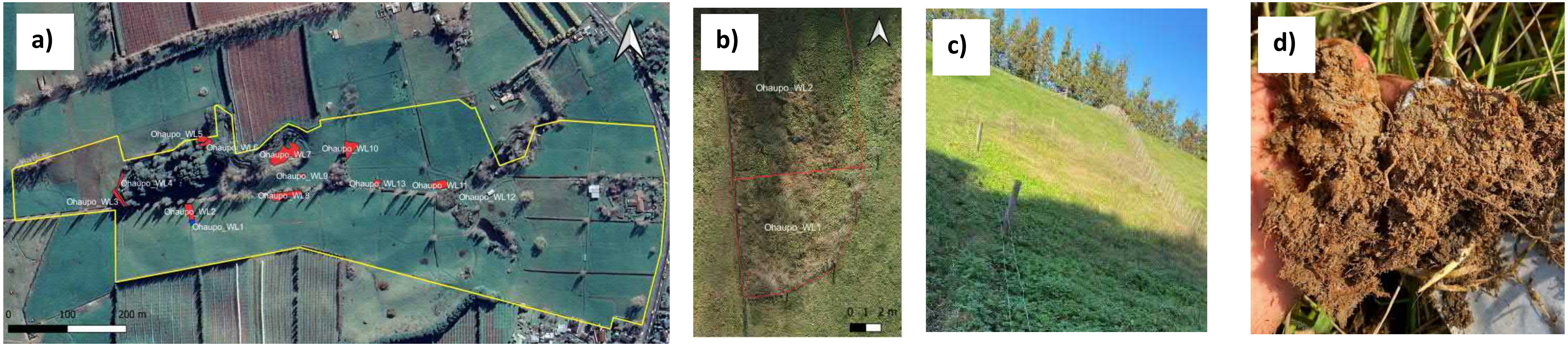
[16] RGB (red, green, blue) refers to imagery created with red, green, and blue primary colours of light added together to reproduce a broad array of colours.

The hydrophytic vegetation present at each of the putative wetlands meets the definition of a ‘natural wetland’ according to the NPS-FM. Despite a high percentage of pasture species in each plot and some areas subject to rain derived pooling during wet weather, pasture species were facultative (FAC) or facultative wetland (FACW) and wetland hydrology was present at the site. Wetland hydrology has been significantly altered by intensive drainage methods. Drainage methods visible on-site included channelisation of streams and visible drainage pipes throughout the property.

Soil at most putative wetland sites showed signs of hydric soil and wetland hydrology. Across the site, the soils appear to be Gley, identified by pale subsoils with reddish mottles. These colours are indicative of saturated low oxygen conditions and a high-water table. The potential wetlands were located in the lower reaches of gently sloping to sloping land. Drainage modification of the site has reduced the extent of the original marsh and altered the inherent properties that slow drainage and cause the soil to be wet. However, alongside hydric soils, most potential wetlands had saturated soil.

Underground drainage piping is present throughout the site. Piping visible in-field discharges into the central drain and was generally located close to the drain, within the surface soil layer. The wetland hydrology and flow pathways of some wetland sites (e.g., Ohaupo_WL9) were difficult to understand and could potentially be explained by the presence of underground drainage systems. Disturbance of these systems will likely result in a change in hydrology and flow pattern surrounding the highlighted putative wetlands.

Wetland Assessment 1: OHAUPO_WL1



Stratum	Species Name	% Cover	Indicator Status
Herb	*Holcus lanatus*	78	FAC
	Ranunculus repens	20	FAC
	Juncus pallidus	1	FACW
	Stellaria media	1	Unknown
Bare ground	Leaf litter, water, bare ground	0	N/A

- Number of dominant species across all strata: 2
- Percent of Dominant Species that are OBL, FACW and/or FAC: 100%
- Dominant species noted in blue

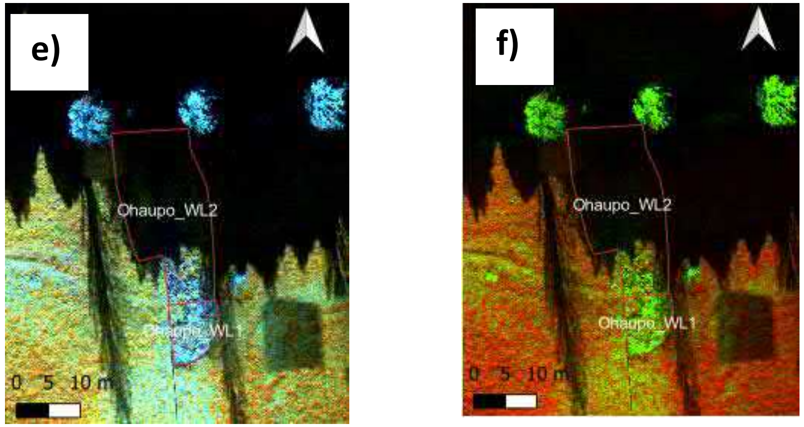
Rapid Test: Fail

Dominance Test: Pass

Hydric Soils Test: Fail

Hydrology Test: Fail

Prevalence Test: Fail

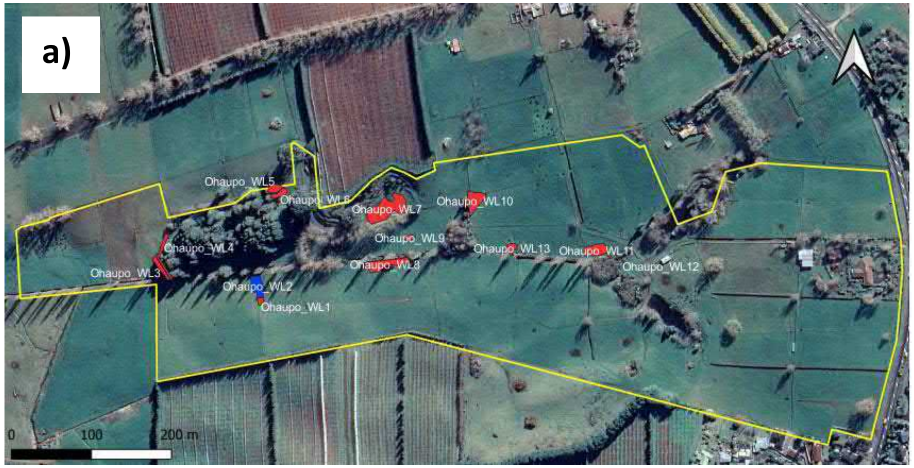


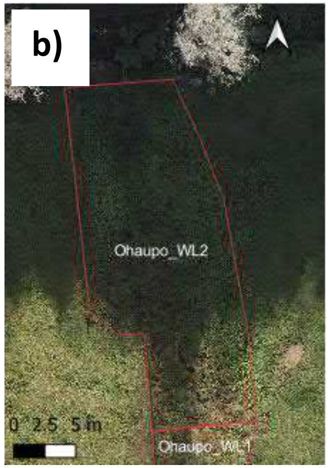
Notes/results: Fenced site upslope of Ohaupo_WL2. Distinct change in vegetation type and lack of saturated soil/surface pooling from WL2 to WL1. WL1 dominated by facultative species, hydric sandy-clay soils present with mottling and low chroma colours suggesting the site is subject to rising groundwater (seasonal affect), but significantly less saturated than WL2. The site marginally failed the hydric soils test as some mottling is present but the soil is unsaturated. The site failed the prevalence test given the result (2.99) was marginal (close to 3) and the site is dominated by facultative pasture species. Therefore, the site cannot be classed as a wetland.

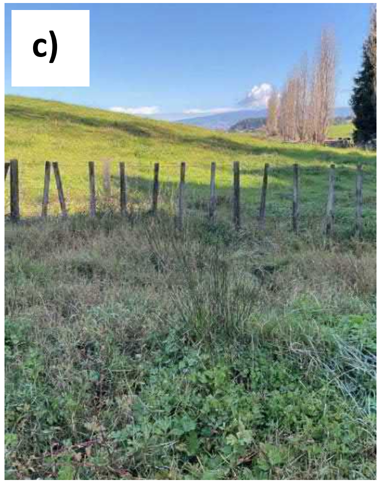
Figures of WL1: a) site map with WL1 highlighted in blue; b) aerial RGB image; c) photograph of hydric soil; d) landscape RGB photograph; e) CIR and; f) FCC colour composite imagery

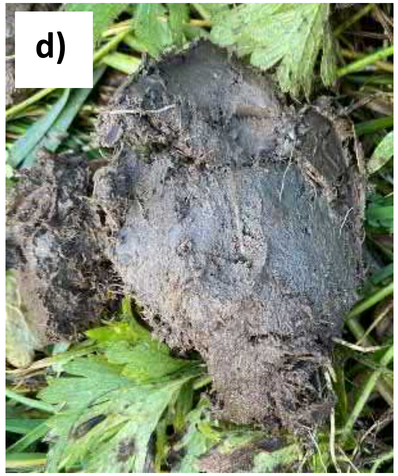
Natural inland wetland: No

Wetland Assessment 2: OHAUPO_WL2









Stratum	Species Name	% Cover	Indicator Status
Herb	*Ranunculus repens*	60	FAC
	Holcus lanatus	20	FAC
	Paspalum distichum	10	FACW
	Juncus pallidus	8	FACW
	Stellaria media	1	Unknown
	Trifolium repens	1	FACU
Bare ground	Leaf litter, water, bare ground	0	N/A

- Number of dominant species across all strata: 2
- Percent of Dominant Species that are OBL, FACW and/or FAC: 100%
- Dominant species noted in blue

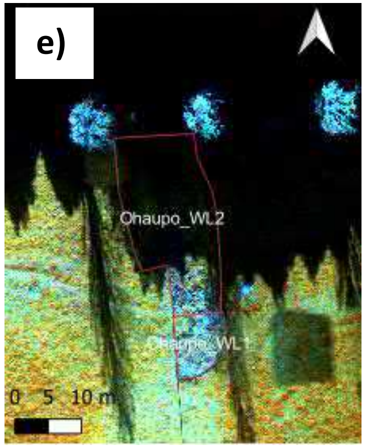
Rapid Test: Fail

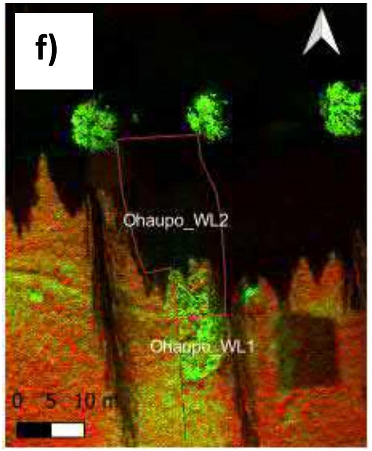
Dominance Test: Pass

Hydric Soils Test: Pass

Hydrology Test: Pass

Prevalence Test: Pass





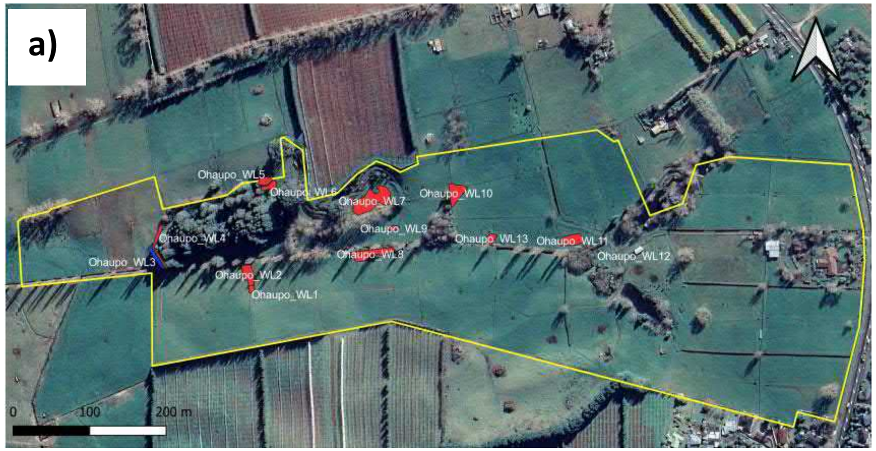
Notes/results: Fenced wetland on slope, downgradient of OhaupoWL_1, discharging into the central drain. Saturated soil with low chroma colours, minor mottling, and organic material at 10-15cm depth. Hydrophytic vegetation present, although facultative pasture species dominate. The site passed the Prevalence Test (2.83).

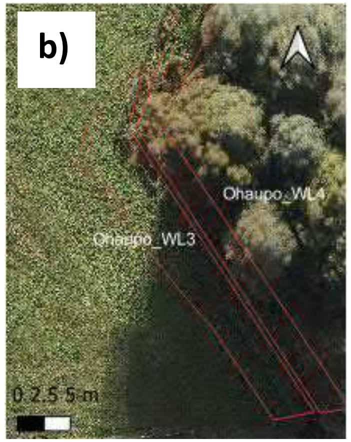
Multiple primary indicators of wetland hydrology were present, including surface water, soil saturation, and water marks on the fence line, therefore the wetland passed the hydrology test.

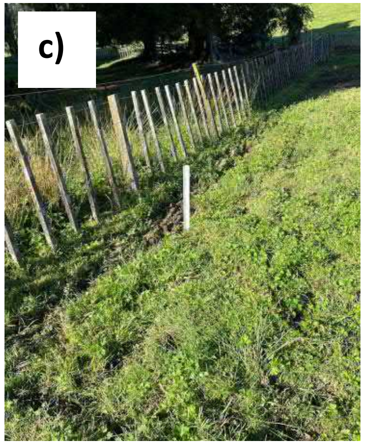
Figures of WL2: a) site map with WL2 highlighted in blue; b) aerial RGB image; c) photograph of hydric soil; d) landscape RGB photograph; e) CIR and; f) FCC colour composite imagery

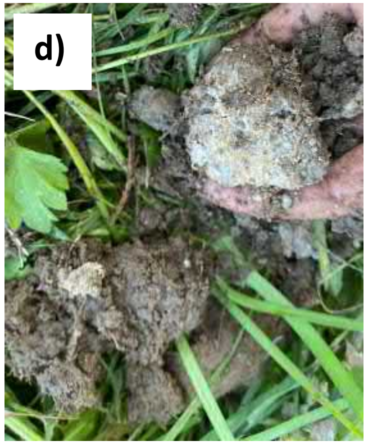
Natural inland wetland: Yes

Wetland Assessment 3: OHAUPO_WL3









Stratum	Species Name	% Cover	Indicator Status
Herb	*Ranunculus repens* *Holcus lanatus* *Paspalum distichum* *Juncus pallidus* *Persicaria hydropiper*	70 20 8 1 1	FAC FAC FACW FACW FACW
Bare ground	Leaf litter, water, bare ground	0	N/A

- Number of dominant species across all strata: 2
- Percent of Dominant Species that are OBL, FACW and/or FAC: 100%
- Dominant species noted in blue

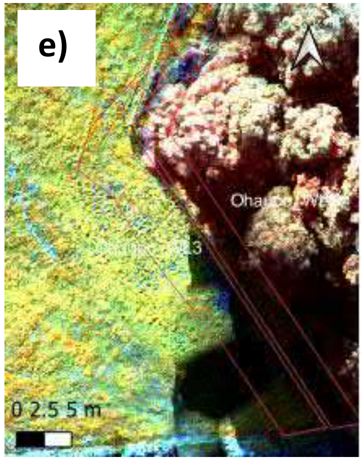
Rapid Test: Fail

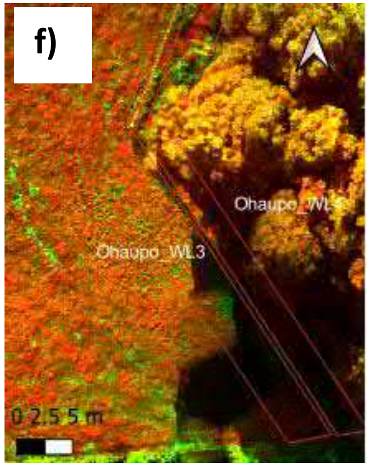
Dominance Test: Pass

Hydric Soils Test: Fail

Hydrology Test: Fail

Prevalence Test: Fail



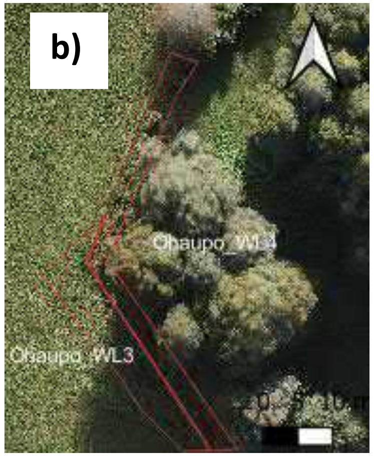


Notes/results: Unfenced section of paddock dominated by creeping buttercup (***Ranunculus repens***). Surface soil was unsaturated with mottling and low chroma colours and a significant amount of pugging existed due to stock access. Despite the presence of mottling, the soil was unsaturated, therefore the hydric soils test failed so this site cannot be considered a natural inland wetland. Area would benefit from restoration and with engineering design, could be integrated into the adjacent wetland.

Figures of WL3: a) site map with WL3 highlighted in blue; b) aerial RGB image; c) photograph of hydric soil; d) landscape RGB photograph; e) CIR and; f) FCC colour composite imagery

Natural inland wetland: No

Wetland Assessment 4 : OHAUPO_WL4

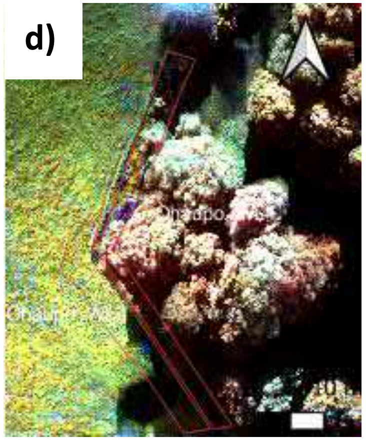


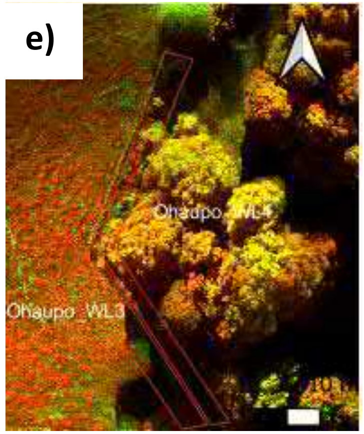
Stratum	Species Name	% Cover	Indicator Status
Herb	*Juncus pallidus* *Ranunculus repens* *Holcus lanatus*	50 30 20	FACW FAC FAC
Bare ground	Leaf litter, water, bare ground	0	N/A

- Number of dominant species across all strata: 3
- Percent of Dominant Species that are OBL, FACW and/or FAC: 100%
- Dominant species noted in blue

Rapid Test: Fail

Dominance Test: Pass





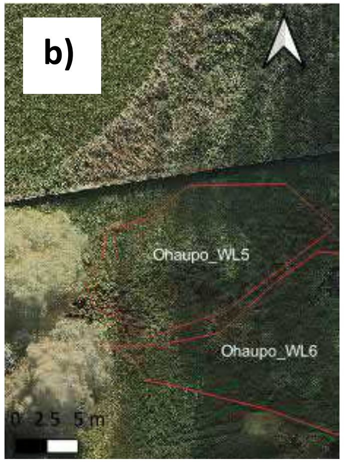
Notes/results: Fended riverine wetland/stream channel underneath Kahikatea stand, adjacent to Ohaupo_WL3. Stream appears to be channelised and flows adjacent to the Kahikatea stand, discharging into the site's central drain. Hydrophytic giant soft rush (***Juncus pallidus***) dominates the vegetation type, although 50% of dominants are FAC, therefore, a Hydric Soils Test was undertaken.

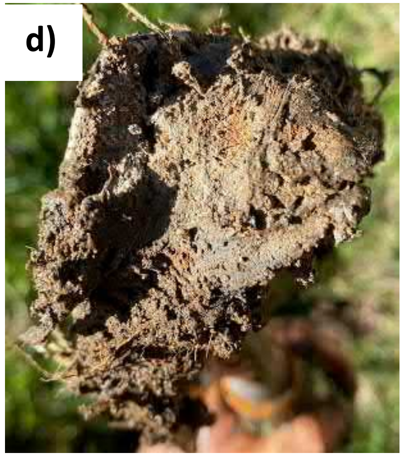
Multiple primary indicators of wetland hydrology were present. Soil was saturated and surface water was slowly flowing in the centre of the channel, therefore the wetland passed the hydrology test.

Figures of WL4: a) site map with WL4 highlighted in blue; b) aerial RGB image; c) landscape RGB photograph; d) CIR and; e) FCC colour composite imagery

Natural inland wetland: Yes

Wetland Assessment 5: OHAUPO_WL5





Stratum	Species Name	% Cover	Indicator Status
Herb	*Juncus pallidus*	60	FACW
	Holcus lanatus	20	FAC
	Paspalum distichum	15	FACW
	Ranunculus repens	5	FAC
Bare ground	Leaf litter, water, bare ground	0	N/A

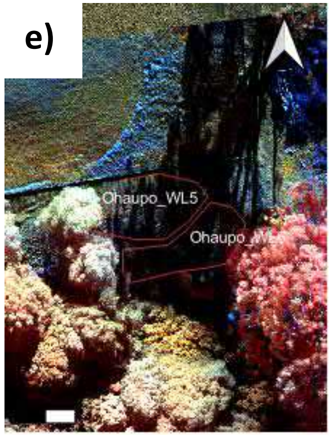
- Number of dominant species across all strata: 2
- Percent of Dominant Species that are OBL, FACW and/or FAC: 100%
- Dominant species noted in blue

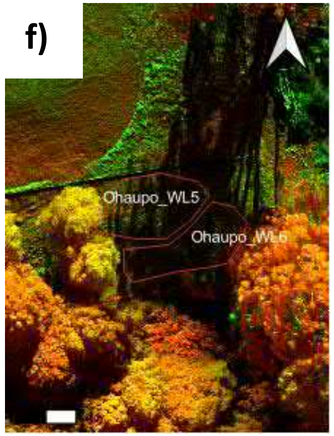
Rapid Test: Fail

Dominance Test: Pass

Hydric Soils Test: Pass

Hydrology Test: Pass





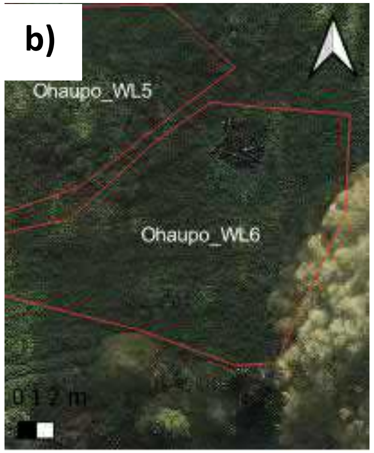
Notes/results: Hydrophytic vegetation dominant (60% giant soft rush), hydric soils with mottling and low chroma colours indicative of a Gley soil. Water pooling on surface, likely groundwater input based on sheens and obvious flow pathway towards channelised stream. Site in close proximity to drained Kahikatea stand.

Multiple primary indicators of wetland hydrology were present, including surface water, soil saturation, and groundwater sheens, therefore the wetland passed the hydrology test and the site is consistent with a natural inland wetland.

Figures of WL5: a) site map with WL5 highlighted in blue; b) aerial RGB image; c) photograph of hydric soil; d) landscape RGB photograph; e) CIR and; f) FCC colour composite imagery

Natural inland wetland: Yes

Wetland Assessment 6: OHAUPO_WL6



Stratum	Species Name	% Cover	Indicator Status
Herb	*Ranunculus repens* *Holcus lanatus* *Juncus pallidus*	70 28 2	FAC FAC FACW
Bare ground	Leaf litter, water, bare ground	0	N/A

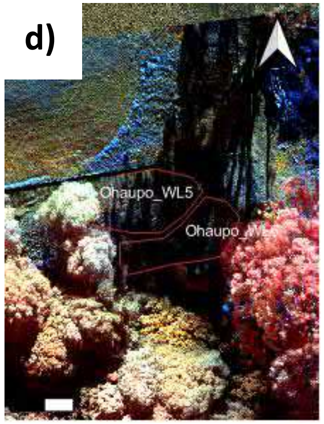
- Number of dominant species across all strata: 2
- Percent of Dominant Species that are OBL, FACW and/or FAC: 100%
- Dominant species noted in blue

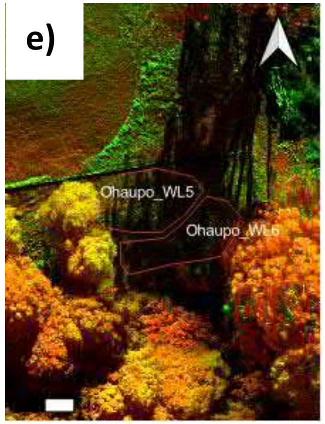
Rapid Test: Fail

Dominance Test: Pass

Hydric Soils Test: Pass

Hydrology Test: Pass





Notes/results: Site subject to surface pooling, dominated by facultative species, some hydrophytic rushes present (2%), hydric soils (partly saturated with some mottling). Downgradient from Ohaupo_WL5 in basin. Site in close proximity to drained Kahikatea stand. The soil was saturated in close proximity to the Kahikatea stand along with multiple primary indicators of wetland hydrology, including surface water, soil saturation, and sheens on pooled groundwater, therefore the wetland passed the hydrology test, and the site is consistent with a natural inland wetland.

Figures of WL6: a) site map with WL6 highlighted in blue; b) aerial RGB image; c) landscape RGB photograph; d) CIR and; e) FCC colour composite imagery

Natural inland wetland: Yes

Wetland Assessment 7: OHAUPO_WL7

Stratum	Species Name	% Cover	Indicator Status
Herb	*Paspalum distichum*	45	FACW
	Holcus lanatus	30	FAC
	Ranunculus repens	15	FAC
	Juncus pallidus	10	FACW
Bare ground	Leaf litter, water, bare ground	0	N/A

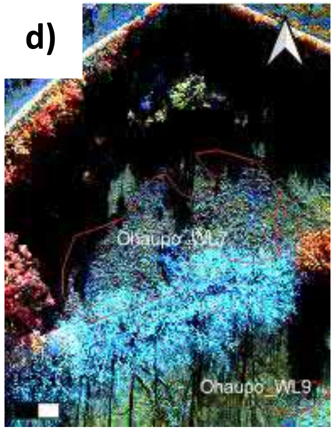
- Number of dominant species across all strata: 2
- Percent of Dominant Species that are OBL, FACW and/or FAC: 100%
- Dominant species noted in blue

Rapid Test: Fail

Dominance Test: Pass

Hydric Soils Test: Pass

Hydrology Test: Pass



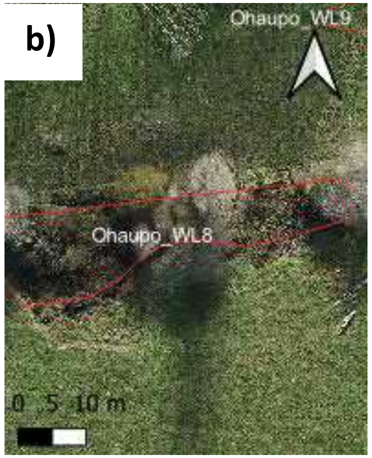
Notes/results: Hydrophytic vegetation present, surface water pooling and groundwater slowly flowing towards central drain. Hydric soils with distinct mottling, no odour, low chroma colours. Very wet site with sheens and iron staining.

Multiple primary indicators of wetland hydrology were present, including surface water, soil saturation, groundwater flow, and iron deposits therefore the wetland passed the hydrology test, and is consistent with a natural inland wetland.

Figures of WL7: a) site map with WL7 highlighted in blue; b) aerial RGB image; c) landscape RGB photograph; d) CIR and; e) FCC colour composite imagery

Natural inland wetland: Yes

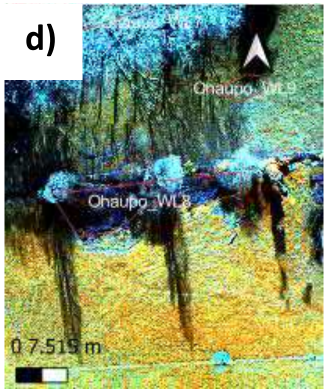
Wetland Assessment 8: OHAUPO_WL8

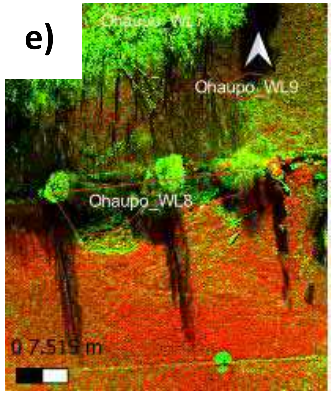


Stratum	Species Name	% Cover	Indicator Status
Herb	*Carex secta*	80	OBL
Bare ground	Leaf litter, water, bare ground	0	N/A

- Number of dominant species across all strata: 1
- Percent of Dominant Species that are OBL, FACW and/or FAC: 100%
- Dominant species noted in blue

Rapid Test: Pass





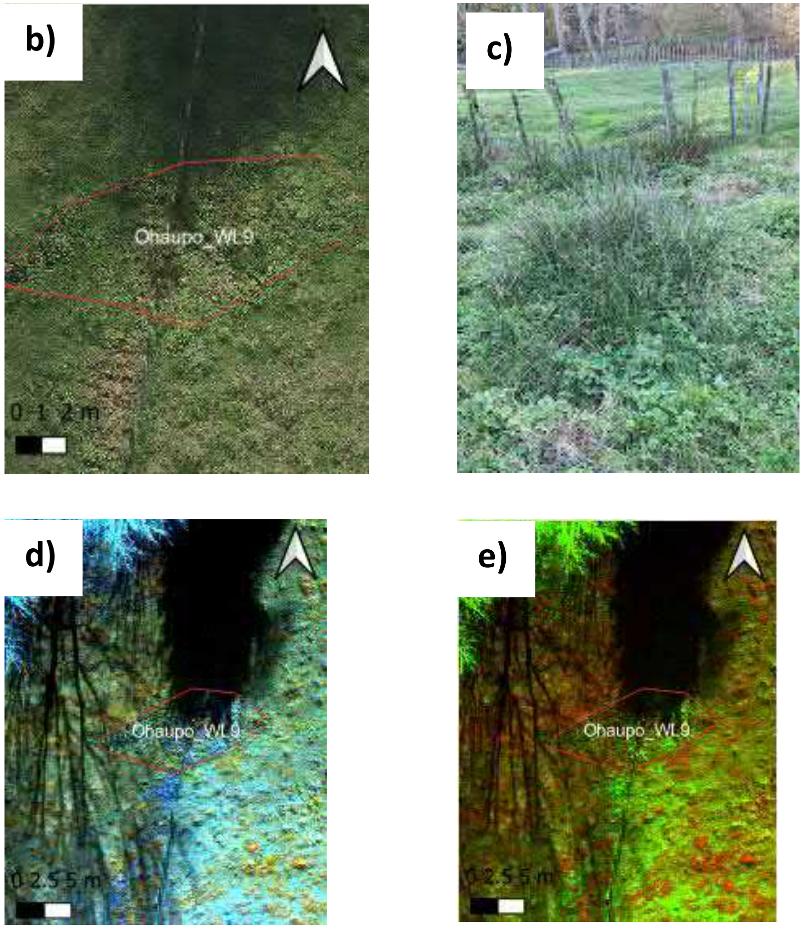
Notes/results: Extent of wetland not fully assessed due to accessibility. From viewpoint (through fence line, across stream) sedge (***Carex secta***) was the only plant species present. Aerial imagery revealed the extent of the wetland, running adjacent to the site's central drain.

Soil was saturated at this site (primary indicator of wetland hydrology), therefore the wetland passed the hydrology test, and is consistent with a natural inland wetland.

Figures of WL8: a) site map with WL8 highlighted in blue; b) aerial RGB image; c) landscape RGB photograph; d) CIR and; e) FCC colour composite imagery

Natural inland wetland: Yes

Wetland Assessment 9: OHAUPO_WL9



Stratum	Species Name	% Cover	Indicator Status
Herb	*Holcus lanatus* *Ranunculus repens* *Juncus pallidus*	40 40 20	FAC FAC FACW
Bare ground	Leaf litter, water, bare ground	0	N/A

- Number of dominant species across all strata: 3
- Percent of Dominant Species that are OBL, FACW and/or FAC: 100%
- Dominant species noted in blue

Rapid Test: Fail

Dominance Test: Pass

Hydric Soils Test: Pass

Hydrology Test: Pass

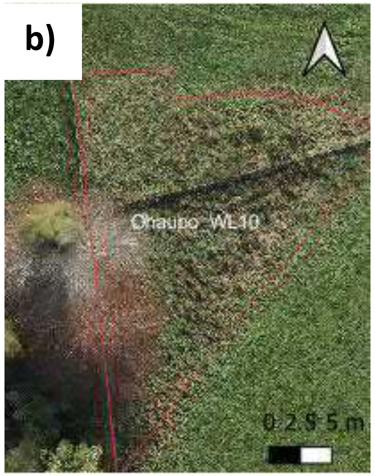
Notes/results: Small (~5m²) area of hydrophytic vegetation with hydric soils. Wetland hydrology not immediately obvious, but multispectral aerial imagery reveals the flow pathway into the central drain. Site likely has underground drainage piping.

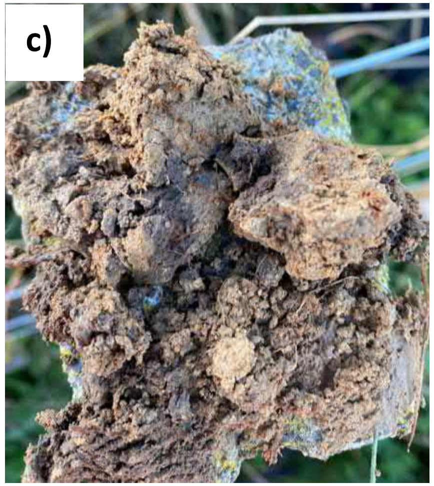
Soil was saturated and surface water pooling was present at this site (primary indicators of wetland hydrology), therefore the wetland passed the hydrology test, and is consistent with a natural inland wetland.

Figures of WL9: a) site map with WL9 highlighted in blue; b) aerial RGB image; c) landscape RGB photograph; d) CIR and; e) FCC colour composite imagery

Natural inland wetland: Yes

Wetland Assessment 10: OHAUPO_WL10





Stratum	Species Name	% Cover	Indicator Status
Herb	N/A	N/A	N/A
Bare ground	Leaf litter, water, bare ground	0	N/A

- Number of dominant species across all strata: N/A
- Percent of Dominant Species that are OBL, FACW and/or FAC: N/A
- Dominant species noted in blue

Rapid Test: Fail

Dominance Test: N/A

Hydric Soils Test: Fail

Hydrology Test: Fail

Prevalence Test: N/A

Notes/results: Not fully assessed in field. Hydrophytic vegetation (***Juncus pallidus***) and unsaturated partially hydric soils were present within the site. However, the absence of surface pooling or sheens, the position of the site at the lowest point of the sloping, basin-like paddock, and higher chroma soils with worms suggests this site is more affected by seasonal surface flooding than wetland hydrology. The area was also unfenced with a significant amount of pugging. The Prevalence Test was not applicable as vegetation was not fully assessed, although the site is assessed as highly unlikely to be a wetland.

Figures of WL10: a) site map with WL10 highlighted in blue; b) aerial RGB image; c) photograph of hydric soil; d) CIR and; e) FCC colour composite imagery

Natural inland wetland: No

Wetland Assessment 11: OHAUPO_WL11

Stratum	Species Name	% Cover	Indicator Status
Herb	*Juncus pallidus*	40	FACW
	Ranunculus repens	30	FAC
	Holcus lanatus	20	FAC
	Paspalum distichum	8	FACW
	Persicaria hydropiper	1	FACW
	Rumex obustifolius	1	FAC
Bare ground	Leaf litter, water, bare ground	0	N/A

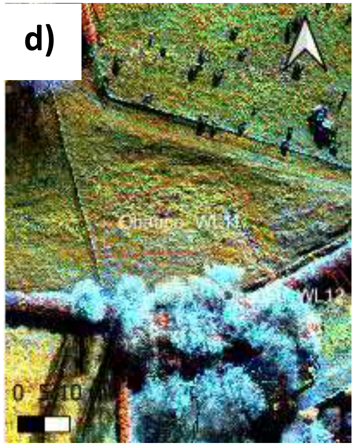
- Number of dominant species across all strata: 3
- Percent of Dominant Species that are OBL, FACW and/or FAC: 100%
- Dominant species noted in blue

Rapid Test: Fail

Dominance Test: Pass

Hydric Soils Test: Pass

Hydrology Test: Pass



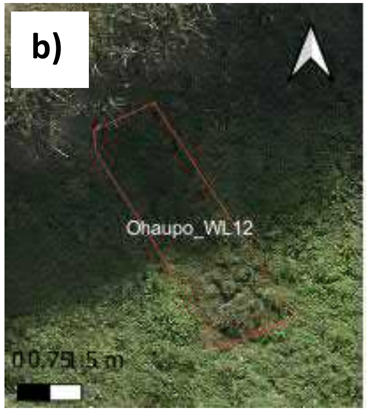
Notes/results: Hydrophytic vegetation, unsaturated hydric soils, lack of surface pooling. Drainage channel into site's central drain shows clear pathway of flow.

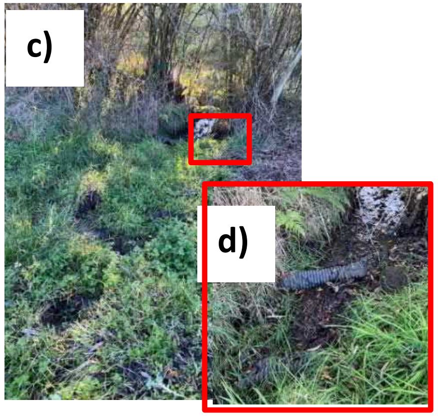
Multiple primary indicators of wetland hydrology were present, including surface water, soil saturation, groundwater flow, and iron deposits therefore the wetland passed the hydrology test, and is consistent with a natural inland wetland.

Figures of WL11: a) site map with WL11 highlighted in blue; b) aerial RGB image; c) landscape RGB photograph; d) CIR and; e) FCC colour composite imagery

Natural inland wetland: Yes

Wetland Assessment 12: OHAUPO_WL12





Stratum	Species Name	% Cover	Indicator Status
Herb	*Juncus pallidus*	50	FACW
	Ranunculus repens	25	FAC
	Holcus lanatus	15	FAC
	Paspalum distichum	8	FACW
	Juncus articulatus	1	FACW
	Trifolium repens	1	FACU
Bare ground	Leaf litter, water, bare ground	0	N/A

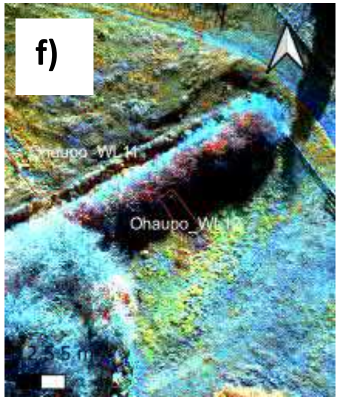
- Number of dominant species across all strata: 2
- Percent of Dominant Species that are OBL, FACW and/or FAC: 100%
- Dominant species noted in blue

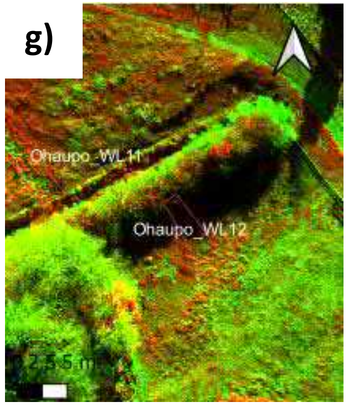
Rapid Test: Fail

Dominance Test: Pass

Hydric Soils Test: Pass

Hydrology Test: Pass





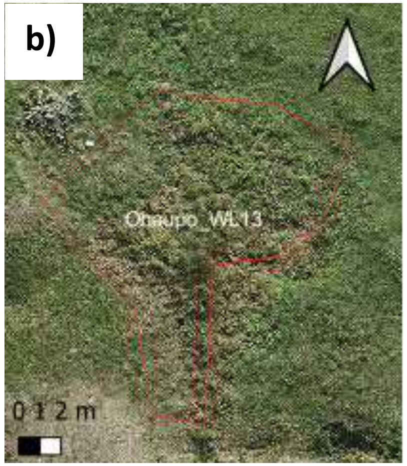
Notes/results: Small (2x1m) wetland upslope of central drain. Wetland hydrology, vegetation, and hydric soils present. Sheens in pooled surface water. Appears to be channelised with water source at the top of the slope. Drainage pipes directing water downslope into drain.

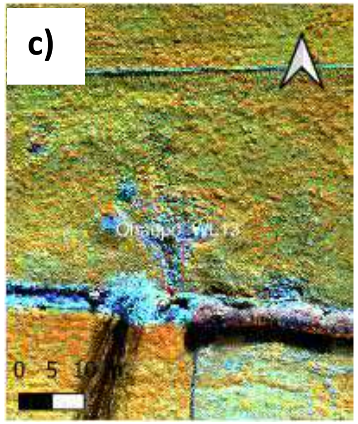
Site is consistent with a natural inland wetland.

Figures of WL12: a) site map with WL12 highlighted in blue; b) aerial RGB image; c) landscape RGB photograph; d) inset image from photograph c) of drainage piping; e) photograph of hydric soil; f) CIR and; g) FCC colour composite imagery

Natural inland wetland: Yes

Wetland Assessment 13: OHAUPO_WL13





Stratum	Species Name	% Cover	Indicator Status
Herb	N/A	N/A	N/A
Bare ground	Leaf litter, water, bare ground	0	N/A

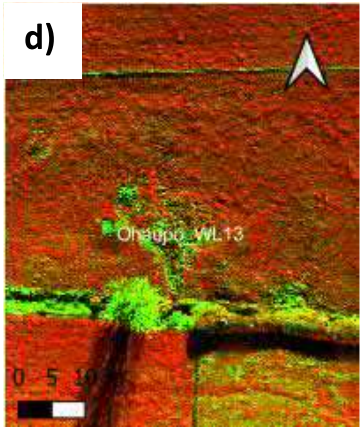
- Number of dominant species across all strata: N/A
- Percent of Dominant Species that are OBL, FACW and/or FAC: N/A
- Dominant species noted in blue

Rapid Test: N/A

Dominance Test: N/A

Hydric Soils Test: N/A

Prevalence Test: N/A



Notes/results: Detected after initial wetland delineation visit using CIR and FCC imagery and unable to get in-field photographs or hydrophytic vegetation identification. Therefore, hydric soils were unable to be assessed and the Prevalence Test was unable to be calculated.

Figures of WL13: a) site map with WL13 highlighted in blue; b) aerial RGB image; c) CIR and; e) FCC colour composite imagery

Natural inland wetland: Undetermined

SUMMARY

Wetland Assessment

The subject site was found to support nine natural inland wetland units within the identified area as the following criteria were met:

- Ten of the thirteen sites were assessed for hydrophytic vegetation using Wetland Delineation Protocols[2].
- One of the vegetation units Passed the Rapid Test and ten passed the Dominance Test, with plant species composition typical of wetlands.
- Four putative wetland sites Passed the Hydric Soils Test and Hydrology Test indicative of wetland hydrology.
- Three units were not considered natural inland wetlands (Ohaupo WL1,3 & 10) due to >50%exotic pasture species, and failed the hydric soil and wetland hydrology tests.
- One of the thirteen sites (Ohaupo_WL13) was identified after the field-visit using aerial imagery, proving this to be a useful tool in wetland delineation assessments. However, further in-field is required to fully characterise this potential wetland.
- These permanently and intermittently wet areas support plants that are adapted to wet conditions, which aligns with the ***Resource Management Act 1991*** definition of a wetland.
- Evidence of hydric soils[2] and wetland hydrology during the applicable hydrophytic vegetation growing season[3].
- The site has been subject to intensive drainage, as indicated by the fragmentation of wetland units, channelisation of streams including the site's central drain, visible drainage piping across the site, and the extent of unsaturated soil relative to the extent of the historic marshland[13]. This has largely changed wetland hydrology and dominance of wetland species.

Recommendations

This Wetland Delineation Report will influence the subdivision master design, so the following recommendations have been made with respect to the wetland areas:

- A water budget should be prepared for the site by a suitability qualified wetland hydrologist to determine present and future yield from site development and assess hydraulic neutrality. Maintaining groundwater levels through hydraulic neutrality should preserve any existing wetland character.
- Ensure stock access is excluded from the identified wetland areas[17] and undertake enhancement planting within the wetlands. With the proposed change in land use, ongoing plantings in close proximity should be compatible, indigenous species that are already present shall be used to ensure no invasion of prevailing pest species.
- Undergo an EcIA to determine if the site is host to significant indigenous flora and fauna (e.g., wetlands can provide important fish spawning habitats) and detail any specific impacts due to the private plan change. Additionally, undergo herpetofauna surveys as part of the EcIA to identify if the site is a possible habitat for bats and lizards. Furthermore, an EcIA would provide the opportunity to delineate and characterise wetlands (Ohaupo_WL13) captured by aerial imagery after the initial site investigations.

[17] Methodology for deriving stock exclusion low-slope land extent for the Resource Management (Stock Exclusion) Regulations 2020 (Stock Exclusion Regulations in place by July 2025).

- Undertake ongoing weed and mammalian pest control within the wetlands, to enhance ecological values.
- Protect the Kahikatea stand and the fragmented wetlands within the site (perhaps listing as a Significant Natural Area (SNA)).
- Buffer the wetlands with a riparian margin of terrestrial species if practicable within spatial constraints, to provide refuge for biota (avifauna and potentially herpetofauna) and a naturalised vegetation sequence.
- Consider also treating the three wet areas that were not classified as natural inland wetlands (OhaupoWL1,3 & 10) in the same manner required for those with the classification (e.g., wetland planting, fencing and managing stock access, excluding from development area).This would allow for more ecological connectivity, create carbon sinks, and increase visual amenity of the site.
- This document is recommended to be a working document, which is subject to changes in wetland regulations (NPS-FM and NES-F changes) and shall be updated on the findings after the EcIA.

Please do not hesitate to contact me with any questions regarding the information contained in this memo.

Regards,

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APPENDIX A DIGITAL TERRAIN MODEL IMAGERY

Figure A 1: Figure 1: Digital Terrain Model (DTM) Index Imagery illustrating the terrain of the landscape and the likely position of surface water pooling with potential wetland polygons. Index colour scheme ranges from deep blue (indicating lower elevation) to bright yellow (indicating higher elevation

APPENDIX B TABLES AND CALCULATIONS

Table B 1: Percentage cover of plant species within the vegetation types assessed within Ohaupo_WL1

Stratum	Species Name	% Cover	Dominant Species?	Indicator Status
Tree	N/A	0	N/A	N/A
Sapling/shrub	N/A	0	N/A	N/A
Herb	Holcus lanatus Ranunculus repens Juncus Pallidus Stellaria media	78 20 1 1	Yes Yes No No	FAC FAC FACW Unknown
Bare ground	Leaf litter, water, bare ground	0	N/A	N/A
Number of dominant species across all strata: 2 Percent of Dominant Species that are OBL, FACW and/or FAC: 99%				

Table B 2: Percentage cover of plant species within the vegetation types assessed within Ohaupo_WL2

Stratum	Species Name	% Cover	Dominant Species?	Indicator Status
Tree	N/A	0	N/A	N/A
Sapling/shrub	N/A	0	N/A	N/A
Herb	Ranunculus repens Holcus lanatus Paspalum distichum Juncus Pallidus Stellaria media Trifolium repens	60 20 10 8 1 1	Yes Yes No No No No	FAC FAC FACW FACW Unknown FACU
Bare ground	Leaf litter, water, bare ground	0	N/A	N/A
Number of dominant species across all strata: 2 Percent of Dominant Species that are OBL, FACW and/or FAC: 98%				

Table B 3: Percentage cover of plant species within the vegetation types assessed within Ohaupo_WL3

Stratum	Species Name	% Cover	Dominant Species?	Indicator Status
Tree	N/A	0	N/A	N/A
Sapling/shrub	N/A	0	N/A	N/A
Herb	Ranunculus repens Holcus lanatus Paspalum distichum Juncus Pallidus Persicaria hydropiper	70 20 8 1 1	Yes No No No No	FAC FAC FACW FACW FACW
Bare ground	Leaf litter, water, bare ground	0	N/A	N/A

Number of dominant species across all strata: 2 Percent of Dominant Species that are OBL, FACW and/or FAC: 100%	

Table B 4: Percentage cover of plant species within the vegetation types assessed within Ohaupo_WL4

Stratum	Species Name	% Cover	Dominant Species?	Indicator Status
Tree	N/A	0	N/A	N/A
Sapling/shrub	Rubus spp.	1	No	FACU
Herb	Juncus Pallidus Ranunculus repens Holcus lanatus	50 30 19	Yes Yes No	FACW FAC FAC
Bare ground	Leaf litter, water, bare ground	0	N/A	N/A
Number of dominant species across all strata: 2 Percent of Dominant Species that are OBL, FACW and/or FAC: 99%				

Table B 5: Percentage cover of plant species within the vegetation types assessed within Ohaupo_WL5

Stratum	Species Name	% Cover	Dominant Species?	Indicator Status
Tree	N/A	0	N/A	N/A
Sapling/shrub	N/A	0 0	N/A N/A	N/A N/A
Herb	Juncus Pallidus Holcus lanatus Paspalum distichum Ranunculus repens	60 20 15 5	Yes Yes No No	FACW FAC FACW FAC
Bare ground	Leaf litter, water, bare ground	0	N/A	N/A
Number of dominant species across all strata: 2 Percent of Dominant Species that are OBL, FACW and/or FAC: 100%				

Table B 6: Percentage cover of plant species within the vegetation types assessed within Ohaupo_WL6

Stratum	Species Name	% Cover	Dominant Species?	Indicator Status
Tree	N/A	0	N/A	N/A
Sapling/shrub	N/A	0 0	N/A N/A	N/A N/A
Herb	Ranunculus repens Holcus lanatus Juncus Pallidus	70 28 2	Yes Yes No	FAC FAC FACW
Bare ground	Leaf litter, water, bare ground	0	N/A	N/A
Number of dominant species across all strata: 2 Percent of Dominant Species that are OBL, FACW and/or FAC: 100%				

Table B 7: Percentage cover of plant species within the vegetation types assessed within Ohaupo_WL7

Stratum	Species Name	% Cover	Dominant Species?	Indicator Status
Tree	N/A	0	N/A	N/A
Sapling/shrub	N/A	0 0	N/A N/A	N/A N/A
Herb	Paspalum distichum Holcus lanatus Ranunculus repens Juncus Pallidus	45 30 15 10	Yes Yes No No	FACW FAC FAC FACW
Bare ground	Leaf litter, water, bare ground	0	N/A	N/A
Number of dominant species across all strata: 2 Percent of Dominant Species that are OBL, FACW and/or FAC: 100%				

Table B 8: Percentage cover of plant species within the vegetation types assessed within Ohaupo_WL8

Stratum	Species Name	% Cover	Dominant Species?	Indicator Status
Tree	N/A	0	N/A	N/A
Sapling/shrub	N/A	0 0	N/A N/A	N/A N/A
Herb	Carex secta	80	Yes	OBL
Bare ground	Leaf litter, water, bare ground	20	N/A	N/A
Number of dominant species across all strata: 2 Percent of Dominant Species that are OBL, FACW and/or FAC: 100%				

Table B 9: Percentage cover of plant species within the vegetation types assessed within Ohaupo_WL9

Stratum	Species Name	% Cover	Dominant Species?	Indicator Status
Tree	N/A	0	N/A	N/A
Sapling/shrub	N/A	0 0	N/A N/A	N/A N/A
Herb	Holcus lanatus Ranunculus repens Juncus Pallidus	40 40 20	Yes Yes Yes	FAC FAC FACW
Bare ground	Leaf litter, water, bare ground	0	N/A	N/A
Number of dominant species across all strata: 2 Percent of Dominant Species that are OBL, FACW and/or FAC: 100%				

Table B 10: Percentage cover of plant species within the vegetation types assessed within Ohaupo_WL10

Stratum	Species Name	% Cover	Dominant Species?	Indicator Status
Tree	N/A	0	N/A	N/A

Sapling/shrub	N/A	0 0	N/A N/A	N/A N/A
Herb		35 2.5 2.5 0.5 2 10.5	Yes No No No No No	OBL FACU FACW Undefined OBL FAC
Bare ground	Leaf litter, water, bare ground	0	N/A	N/A
Number of dominant species across all strata: 2 Percent of Dominant Species that are OBL, FACW and/or FAC: 100%				

Table B 11: Percentage cover of plant species within the vegetation types assessed within Ohaupo_WL11

Stratum	Species Name	% Cover	Dominant Species?	Indicator Status
Tree	N/A	0	N/A	N/A
Sapling/shrub	N/A	0 0	N/A N/A	N/A N/A
Herb	Juncus pallidus Ranunculus repens Holcus lanatus Paspalum distichum Persicaria hydropiper Rumex obustifolius	40 30 20 8 1 1	Yes Yes Yes No No No	FACW FAC FAC FACW FACW FAC
Bare ground	Leaf litter, water, bare ground	0	N/A	N/A
Number of dominant species across all strata: 2 Percent of Dominant Species that are OBL, FACW and/or FAC: 100%				

Table B 12: Percentage cover of plant species within the vegetation types assessed within Ohaupo_WL12

Stratum	Species Name	% Cover	Dominant Species?	Indicator Status
Tree	N/A	0	N/A	N/A
Sapling/shrub	N/A	0 0	N/A N/A	N/A N/A
Herb	Juncus Pallidus Ranunculus repens Holcus lanatus Paspalum distichum Juncus articulatus Trifolium repens	50 25 15 8 1 1	Yes Yes No No No No	FACW FAC FAC FACW FACW FACU
Bare ground	Leaf litter, water, bare ground	0	N/A	N/A
Number of dominant species across all strata: 2 Percent of Dominant Species that are OBL, FACW and/or FAC: 99%				

APPENDIX C NZ WETLAND DETERMINATION DATA FORM

Appendix 1 – NZ Wetland Determination Data Form

WETLAND DETERMINATION DATA FORM – NEW ZEALAND

Project/Site: OhaupO Region: Waikato Sampling Date: ____
Applicant/Owner: Levin Decosta Altitude: ____ Sampling Point/No: 1
Investigator(s): AS / AW Nearby town/city: ____
Landform (hillslope, terrace, etc.): Hillslope / basin Local relief (concave, convex, none): concave Slope (%): ____
Latitude: ____ Longitude: ____ Datum: WGS 84
Soil Map Unit Name: ____
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ____ No ____ (If no, explain in Remarks.)
Are Vegetation ____, Soil ____, or Hydrology ____ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ____
Are Vegetation ____, Soil ____, or Hydrology ____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ____	Is the Sampled Area within a Wetland? Yes ____ No ____
Hydric Soil Present?	Yes ✓ No ____	
Wetland Hydrology Present?	Yes ~~✓~~ No ✓	

Remarks: Ohaupo – WL1 (upland) Barn long ; Ohaupo – WL2 (downgradient) after 4th fence post down stream

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
		= Total Cover	
Sapling/Shrub Stratum (Plot size: ____)			
1.			
2.			
3.			
4.			
5.			
		= Total Cover	
Herb Stratum (Plot size: 2X2M)			
Ohaupo-WL1 1. Upland grass	~~75~~ 80		
2. Ranunculus repens	20		
3. Giant soft rush	1		
4. Chickweed ?	1		
5. (obvious mottling, dry)			
6.			
Ohaupo-WL2 7. Ranunculus repens ~~60%~~	60		
8. Tussock grass (mercer)	40		
9. Sedge	5		
10. chickweed	1%		
11. Clover	1		
12.			
		= Total Cover	

Low chroma, saturated soil.
No odour. Mottling (minor)
Organic material @ 10–15 cm depth.

Remarks:

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ____ (A)
Total Number of Dominant Species Across All Strata: ____ (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: ____ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	____	x 1 = ____
FACW species	____	x 2 = ____
FAC species	____	x 3 = ____
FACU species	____	x 4 = ____
UPL species	____	x 5 = ____
Column Totals:	____ (A)	____ (B)

Prevalence Index = B/A = ____

Hydrophytic Vegetation Indicators:

- __ Dominance Test is >50%
- __ Prevalence Index is ≤3.0[1]
- __ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- __ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ____ No ____

Adapted from US Army Corps of Engineers New Zealand – Version 1.0

Fenced
Sandy clay
Iron mottles

Appendix 1 – NZ Wetland Determination Data Form

WETLAND DETERMINATION DATA FORM – NEW ZEALAND

Project/Site: Ohaupo Region: Waikato Sampling Date: 26/8/22

Applicant/Owner: Lawn Dacosta Altitude: ______ Sampling Point No: ______

Investigator(s): AS, AMW Nearby town/city: Ohaupo / TA

Landform (hillslope, terrace, etc.): slight hillslope Local relief (concave, convex, none): concave Slope (%): ______

Latitude: ______ Longitude: ______ Datum: WGS 84

Soil Map Unit Name: ______

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✓ No ______

Hydric Soil Present? Yes ______ No ______

Wetland Hydrology Present? Yes ______ No ______

Is the Sampled Area within a Wetland? Yes ______ No ______

Remarks:

OhaupoWL3

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
= Total Cover			

Sapling/Shrub Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
= Total Cover			

Herb Stratum (Plot size: 2x2m)	Absolute % Cover	Dominant Species?	Indicator Status
1. Renunculus nefens	70%		
2. Pasture species	30%		
3. Sedge	1%		
4. ~~water weed~~	1%		
5. NOT vietnamese mint			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
= Total Cover			

Remarks:

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- __ Dominance Test is >50%
- __ Prevalence Index is ≤3.0[1]
- __ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- __ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ______ No ______

Adapted from US Army Corps of Engineers New Zealand – Version 1.0

Appendix 1 – NZ Wetland Determination Data Form

WETLAND DETERMINATION DATA FORM – NEW ZEALAND

2025

Project/Site: Ohaupo road Region: Ohaupo Sampling Date: ______

Applicant/Owner: Levin Decosta Altitude: ______ Sampling Point No: ______

Investigator(s): AS / AWW Nearby town/city: TA

Landform (hillslope, terrace, etc.): channel Local relief (concave, convex, none): concave Slope (%): ______

Latitude: ______ Longitude: ______ Datum: WGS 84

Soil Map Unit Name: ______

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ______ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓	No ______	**Is the Sampled Area within a Wetland?** Yes ______ No ______
Hydric Soil Present?	Yes ✓	No ______	
Wetland Hydrology Present?	Yes ✓	No ______	

Remarks:
Ohaupo-WL4
Fenced wetland/stream channel underneath Kahikatea stand mature wetland

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	______ = Total Cover		

Sapling/Shrub Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
	______ = Total Cover		

Herb Stratum (Plot size: 2x2m)	Absolute % Cover	Dominant Species?	Indicator Status
1. Sedge	~~[illegible]~~ 50		
2. Ranunculus repens	~~[illegible]~~ 30		
3. Blackberry	1		
4. pasture	20 ~~[illegible]~~		
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	______ = Total Cover		

Remarks:

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- __ Dominance Test is >50%
- __ Prevalence Index is ≤3.0[1]
- __ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- __ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ______ No ______

Adapted from US Army Corps of Engineers New Zealand – Version 1.0

WL5 + WL6

Appendix 1 – NZ Wetland Determination Data Form

WETLAND DETERMINATION DATA FORM – NEW ZEALAND

Project/Site: Ohapo 2025 Region: Ohapo Sampling Date: 26/5

Applicant/Owner: Levin Decosta Altitude: ________ Sampling Point No: ________

Investigator(s): AS / AWW Nearby town/city: ________

Landform (hillslope, terrace, etc.): hillslope / basin Local relief (concave, convex, none): concave Slope (%): ______

Latitude: ________ Longitude: ________ Datum: WGS 84

Soil Map Unit Name: ________

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ✓ No ______		**Is the Sampled Area within a Wetland?** Yes ______ No ______
Hydric Soil Present? Yes ______ No ______		
Wetland Hydrology Present? Yes ______ No ______		

Remarks: WL5 WL6 sheen on surface water WL6

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size: ______)			
WL5 1. Sedge	60		
2. pasture	40		
3.			
4.			
5.			
6.			
7.			
WL6 8. Ranunculus	70		
9. pasture	25		
10. sedge	2		
11.			
12.			
= Total Cover			

Remarks: Pedology for WL6

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

__ Dominance Test is >50%

__ Prevalence Index is ≤3.0[1]

__ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

__ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ______ No ______

Adapted from US Army Corps of Engineers

New Zealand – Version 1.0

W7

Appendix 1 – NZ Wetland Determination Data Form

WETLAND DETERMINATION DATA FORM – NEW ZEALAND

Project/Site: 2025 ohaupo Region: Ohaupo/Waikato Sampling Date: ______
Applicant/Owner: Leon Decosta Altitude: ______ Sampling Point No: ______
Investigator(s): AS/AWW Nearby town/city: TA/Hamilton
Landform (hillslope, terrace, etc.): ~~terrace~~ basin Local relief (concave, convex, none): concave Slope (%): ______
Latitude: ______ Longitude: ______ Datum: WGS 84
Soil Map Unit Name: ______
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)
Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______
Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ______	Is the Sampled Area within a Wetland? Yes ______ No ______
Hydric Soil Present?	Yes ✓ No ______	
Wetland Hydrology Present?	Yes ______ No ______	

Remarks: Distinct mottling. No odour. Low chroma. Wet veg/ssaining. Flowing GW. Very wet.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Herb Stratum (Plot size: ______)			
1. Knot grass	~~80~~ 75		
2. renunculus	15		
3. Sedge	10		
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	= Total Cover		

Remarks:

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ______ (A)
Total Number of Dominant Species Across All Strata: ______ (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- ___ Dominance Test is >50%
- ___ Prevalence Index is ≤3.0[1]
- ___ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ______ No ______

Adapted from US Army Corps of Engineers

New Zealand – Version 1.0

Appendix 1 – NZ Wetland Determination Data Form

WETLAND DETERMINATION DATA FORM – NEW ZEALAND

2025

Project/Site: Ohaupo Rd. Region: Ohaupo / Waikato Sampling Date: 26/5

Applicant/Owner: Levin Pacosta Altitude: ______ Sampling Point No: ______

Investigator(s): AS / AWW Nearby town/city: Hamilton

Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): concave Slope (%): ______

Latitude: ______ Longitude: ______ Datum: WGS 84

Soil Map Unit Name: ______

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ✓ No ______ ?

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ✓ No ______	**Is the Sampled Area within a Wetland?** Yes ______ No ______
Hydric Soil Present?	Yes ✓ No ______	
Wetland Hydrology Present?	Yes ______ No ✓	

Remarks:

Sulky grass – WL8 on otherside of stream

WL9 – small spot with sedges (unsure of headwater location)

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Herb Stratum (Plot size: ______)			
WL8 1. Sulky grass	100%		
2.	NOT		
3.	FULLY ASSESSED		
4.			
5.			
6.			
7. Pasture			
WL9 8. Renunculus	30		
9. Sedge	20		
10. Kyk	10		
11. Upland grass	40		
12.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- __ Dominance Test is >50%
- __ Prevalence Index is ≤3.0[1]
- __ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- __ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ______ No ______

Remarks:

WL9 = mottling, low chroma colours

Adapted from US Army Corps of Engineers New Zealand – Version 1.0

* Interesting to see w/ multispec

~5m² of hydric soils

Appendix 1 – NZ Wetland Determination Data Form

WETLAND DETERMINATION DATA FORM – NEW ZEALAND

Project/Site: 2025 Ohaupo rd, Region: Waikato Sampling Date: 26/5/22

Applicant/Owner: Lenn Pe Coste Altitude: ______ Sampling Point No: ______

Investigator(s): AS/AMW Nearby town/city: ______

Landform (hillslope, terrace, etc.): ______ Local relief (concave, convex, none): ______ Slope (%): ______

Latitude: ______ Longitude: ______ Datum: WGS 84

Soil Map Unit Name: ______

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ______ No ______ (If no, explain in Remarks.)

Are Vegetation ______, Soil ______, or Hydrology ______ significantly disturbed? Are "Normal Circumstances" present? Yes ______ No ______

Are Vegetation ______, Soil ______, or Hydrology ______ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ______ No ______		**Is the Sampled Area within a Wetland?** Yes ______ No ______
Hydric Soil Present? Yes ______ No ______		
Wetland Hydrology Present? Yes ______ No ______		

Remarks: cut channel, aerial imagery shows drk. colour, often wet, sheens, pipes at hedge line grading w/ drain

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: ______)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: ______)			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		
Herb Stratum (Plot size: ______)			
1. Ranunculus			
2. Sedge			
3. Jointed rush			
4. Tufted species			
5. Soft rush			
6. Knot grass			
7. pasture			
8.			
9.			
10.			
11.			
12.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: ______ (A)

Total Number of Dominant Species Across All Strata: ______ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: ______ (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	______	x 1 = ______
FACW species	______	x 2 = ______
FAC species	______	x 3 = ______
FACU species	______	x 4 = ______
UPL species	______	x 5 = ______
Column Totals:	______ (A)	______ (B)

Prevalence Index = B/A = ______

Hydrophytic Vegetation Indicators:

- __ Dominance Test is >50%
- __ Prevalence Index is ≤3.0[1]
- __ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- __ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ______ No ______

u/g source

#1 Left?

Remarks: 1½ – 2m strip
very small area

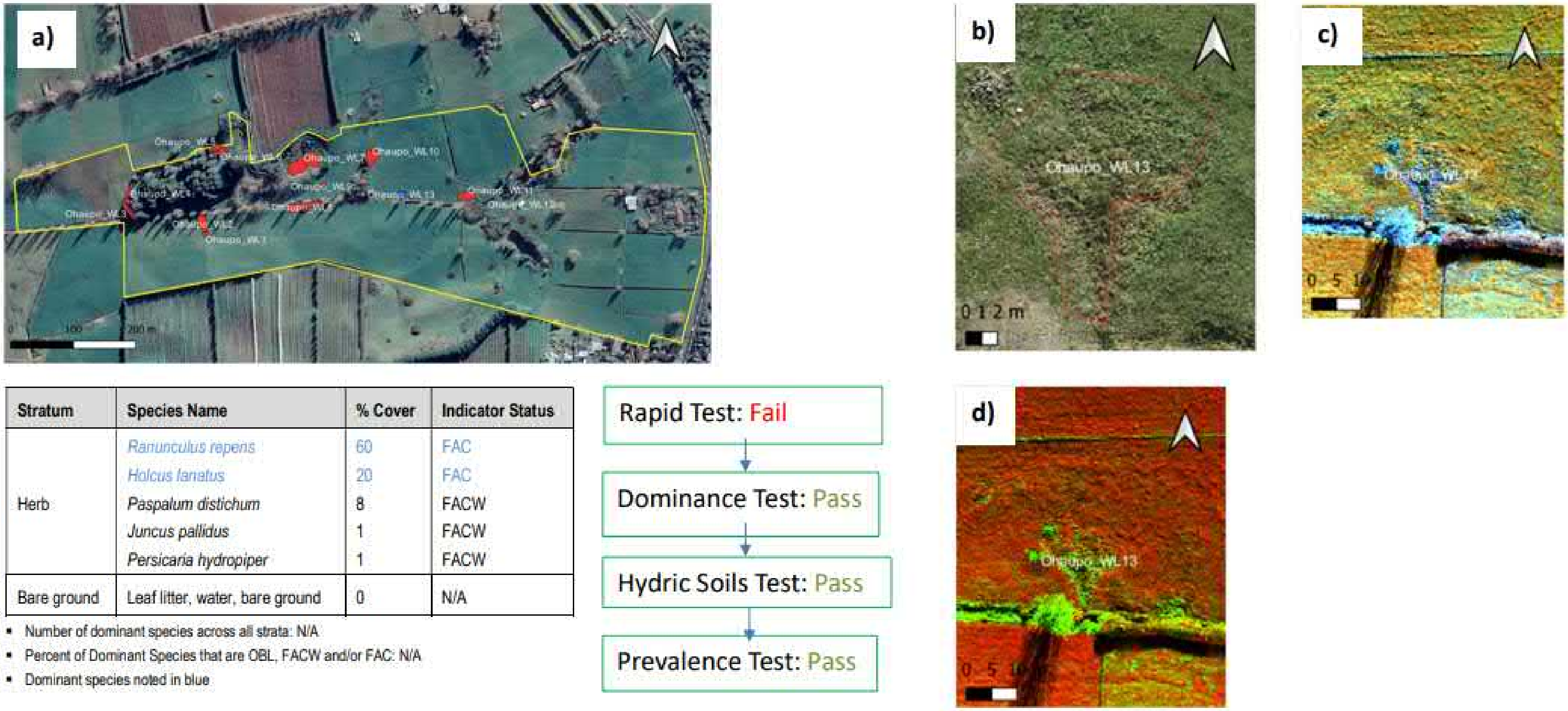
Ohaupo WL12

Adapted from US Army Corps of Engineers

Low chroma soil.

New Zealand – Version 1.0

Wetland Assessment 13: OHAUPO_WL13



Stratum	Species Name	% Cover	Indicator Status
Herb	*Ranunculus repens*	60	FAC
	Holcus lanatus	20	FAC
	Paspalum distichum	8	FACW
	Juncus pallidus	1	FACW
	Persicaria hydropiper	1	FACW
Bare ground	Leaf litter, water, bare ground	0	N/A

- Number of dominant species across all strata: N/A
- Percent of Dominant Species that are OBL, FACW and/or FAC: N/A
- Dominant species noted in blue

Rapid Test: Fail

Dominance Test: Pass

Hydric Soils Test: Pass

Prevalence Test: Pass

Notes/results: Detected after initial wetland delineation visit using CIR and FCC imagery and unable to get in-field photographs or hydrophytic vegetation identification. Therefore, hydric soils were unable to be assessed and the Prevalence Test was unable to be calculated.

Figures of WL13: a) site map with WL13 highlighted in blue; b) aerial RGB image; c) CIR and; e) FCC colour composite imagery

Natural inland wetland: Yes

APPENDIX D RAW EDNA RESULTS

ScientificName	CommonName	Group	524944	524945	524946	524947	524948	524949
Mesocyclops leuckarti	Copepod	Crustaceans	9532	11797	0	11259	11366	7832
Anguilla australis	Shortfin eel	Fish	4568	3795	33	2025	819	4059
Bos taurus	Cattle	Mammals	1139	3594	92	188	141	9
Anas platyrhynchos	Mallard duck	Birds	561	452	142	2149	438	174
Trichosurus vulpecula	Common brushtail possum	Mammals	52	1235	917	26	4	0
Porphyrio melanotus	Pukeko	Birds	203	4	0	32	9	1500
Lumbriculus variegatus	Blackworm	Worms	62	360	85	729	236	0
Aulodrilus pluriseta	Aquatic oligochaete worm	Worms	27	344	38	557	390	0
Acanthocyclops robustus	Copepod	Crustaceans	61	329	0	428	105	0
Dactylis glomerata	Catgrass; cocksfoot	Plants	374	291	0	0	0	242
Gambusia affinis	Mosquitofish	Fish	634	67	0	0	0	0
Holcus lanatus	Yorkshire fog	Plants	670	26	0	0	0	0
Rattus norvegicus	Norway Rat	Mammals	109	111	0	148	159	28
Ranoidea aurea	Green bell frog	Amphibians	91	40	0	322	0	0
Austrosimulium australense	Sandfly	Insects	102	269	0	0	0	0
Zantedeschia aethiopica	Calla lily; Arum lily	Plants	0	0	0	0	0	363
Nais communis/variabilis complex sp. A1	Sludgeworm	Worms	0	96	6	162	82	0
Stentor roeselii	Ciliate	Ciliates	0	0	0	0	0	340
Limnodrilus hoffmeisteri	Redworm	Worms	6	56	0	130	24	0
Chaetogaster diastrophus	Oligochaete worm	Worms	20	49	32	39	35	0
Fringilla coelebs	Common chaffinch	Birds	18	0	0	69	19	30
Orthonychiurus folsomi	Springtail	Springtails	7	37	0	21	17	46
Sturnus vulgaris	Common starling	Birds	25	14	0	24	54	0
Eukerria saltensis	Worm	Worms	10	64	0	36	0	0
Turdus philomelos	Song thrush	Birds	0	0	91	5	5	0
Octolasion cyaneum	Worm	Worms	0	0	0	12	77	0
Triplectides obsoletus	NZ caddisfly	Insects	53	35	0	0	0	0
Beta vulgaris	Sugar beet, beetroot, chard, mangelw	Plants	0	60	0	0	12	0
Prostoma graecense	Freshwater nemertean	Other	57	9	0	0	0	0
Lumbricus castaneus	Worm	Worms	4	22	0	35	0	0
Amynthas corticis	Snake worm	Worms	0	9	0	21	29	0
Hydra vulgaris	Hydra	Cnidarians	14	20	0	24	0	0

Rhopalosiphum padi	Bird cherry-oat aphid	Insects	0	0	0	22	36	0
Zosterops lateralis	Silvereye	Birds	0	0	0	43	0	13
Chamaecyparis lawsoniana	Port Orford cedar, Lawson cypress	Plants	44	12	0	0	0	0
Canis lupus familiaris	Dog	Mammals	0	23	0	0	23	0
Aporrectodea longa	Worm	Worms	15	6	0	0	23	0
Cornus kousa	Flowering dogwood	Plants	0	0	0	0	43	0
Chaetogaster diaphanus	Oligochaete worm	Worms	11	20	0	0	9	0
Hypogastrura purpurescens	Springtail	Springtails	6	23	0	0	11	0
Closterium baillyanum	Charophyte green algae	Other	0	0	0	0	35	0
Octolasion lacteum	Worm	Worms	0	0	0	0	34	0
Passer domesticus	House sparrow	Birds	0	0	0	32	0	0
Turdus merula	Blackbird	Birds	0	0	29	0	0	0
Potamopyrgus antipodarum	Mud Snail	Molluscs	15	4	0	8	0	0
Spumella lacusvadosi	Golden-brown alga	Heterokont a	10	0	0	12	4	0
Lumbricus rubellus	Red earthworm	Worms	0	25	0	0	0	0
Stellaria media	Chickweed	Plants	0	0	0	0	24	0
Mermessus fradeorum		Spiders	0	12	0	0	10	0
Hypogastrura assimilis	Springtail	Springtails	11	0	4	0	7	0
Ectopsocus briggsi	Psocopteran fly	Insects	0	12	0	0	9	0
Aporrectodea caliginosa	Worm	Worms	0	0	0	0	20	0
Deroceras reticulatum	Grey field slug; Grey garden slug	Molluscs	0	0	19	0	0	0
Pinnularia sp. 10 CS-2011	Freshwater diatom	Diatoms	0	0	0	0	19	0
Ceratophysella aff. denticulata L3	Mushroom springtail	Springtails	15	4	0	0	0	0
Rattus rattus	Black Rat	Mammals	0	10	0	0	8	0
Oxyrrhynchium hians	Swartz feather moss	Mosses	0	0	0	0	0	18
Salvia prionitis		Plants	0	0	0	0	0	18
Isachne globosa		Plants	0	0	17	0	0	0
Polyplectropus impluvii		Insects	6	11	0	0	0	0
Cryptomeria japonica	Japanese cedar	Plants	0	0	0	16	0	0
Lumbricus terrestris	Common earthworm	Worms	16	0	0	0	0	0
Porcellio scaber	Woodlouse; Slater	Crustaceans	11	0	0	0	5	0
Paracyclops fimbriatus	Copepod	Crustaceans	0	0	0	0	16	0
Chrysophyceae sp.		Heterokont a	0	9	5	0	0	0

Neanura muscorum	Springtail	Springtails	0	4	0	0	5	4
Phormium tenax	NZ flax	Plants	0	4	0	7	0	0
Aulacorthum solani	Foxglove aphid	Insects	0	0	0	0	0	11
Frustulia vulgaris	Diatom	Diatoms	11	0	0	0	0	0
Oxyethira albiceps	Micro caddisfly	Insects	5	6	0	0	0	0
Cercyon haemorrhoidalis	Water scavenger beetle	Insects	0	0	11	0	0	0
Dermatophagoides pteronyssinus	House dust mite; Dust mite	Mites and tic	0	0	0	0	9	0
Oeconesus maori	NZ caddisfly	Insects	9	0	0	0	0	0
Capua dura		Insects	0	9	0	0	0	0
Henlea ventriculosa	Worm	Worms	0	8	0	0	0	0
Ilyodrilus templetoni	Aquatic worm	Worms	0	0	0	0	7	0
Paratanytarsus grimmii	Chironomid	Insects	7	0	0	0	0	0
Monomastix minuta	Green alga	Green algae	0	0	0	7	0	0
Gymnorhina tibicen	Magpie	Birds	6	0	0	0	0	0
Emberiza citrinella	Yellowhammer	Birds	0	0	0	6	0	0
Tomocerus minor	Springtail	Springtails	0	6	0	0	0	0
Sphaerium novaezelandiae		Molluscs	0	6	0	0	0	0
Pseudoeconesus bistirpis		Insects	6	0	0	0	0	0
Enchytraeus norvegicus	Worm	Worms	0	6	0	0	0	0
Eiseniella tetraedra	Squaretail worm	Worms	0	6	0	0	0	0
Oryctolagus cuniculus	European Rabbit	Mammals	0	5	0	0	0	0
Cyclotella cryptica	Brackish-water diatom	Diatoms	0	0	0	0	5	0
Myzus ornatus	Ornate aphid; violet aphid	Insects	0	0	0	0	5	0
Mythimna separata	Armyworm	Insects	5	0	0	0	0	0
Isotenes miserana	Moth	Insects	5	0	0	0	0	0
Habrotrocha elusa elusa	Rotefer	Rotifers	0	5	0	0	0	0
Isotomurus palustris	Marsh springtail	Springtails	4	0	0	0	0	0
Nasturtium officinale	Watercress	Plants	4	0	0	0	0	0
Juncus parryi	Rush	Plants	0	0	0	4	0	0
Nitzschia palea	Diatom	Diatoms	4	0	0	0	0	0
Onychiuridae sp. SA-2013	Springtail	Springtails	0	0	0	0	4	0
Bimastos rubidus	Worm	Worms	0	0	0	4	0	0
Synura		Heterokont a	1704	1784	0	1273	1184	2267

Populus	Poplars; aspens; cottonwoods	Plants	1159	2845	1983	722	23	0
Ranunculus	Buttercups; spearworts; water crowfo	Plants	484	968	1300	1608	471	265
Cryptomonas		Cryptomonac	925	845	0	1609	668	768
Simocephalus		Crustaceans	0	0	0	0	0	1698
Coleps		Ciliates	305	343	0	269	280	422
Chaetonotus	Gastrotrich	Other	210	262	66	157	599	4
Vorticella		Ciliates	95	348	485	24	185	41
Carchesium		Ciliates	78	282	683	21	61	0
Persicaria	Knotweeds; Smartweeds	Plants	0	59	405	117	129	344
Holcus	Soft-grasses; velvet grasses	Plants	817	64	13	78	65	12
Trachelius		Ciliates	679	167	0	0	122	0
Ludwigia	Primrose-willows; water-purslanes; wa	Plants	171	10	739	9	0	31
Actinidia	Kiwifruit; chinese gooseberry	Plants	0	0	0	675	189	0
Nais	Sludgeworm	Worms	34	206	7	360	206	18
Berberis	Barberries	Plants	49	98	0	88	491	25
Dinobryon		Heterokont a	99	102	0	100	228	105
Mallomonas		Heterokont a	47	66	0	143	41	320
Pinus	Pines	Plants	0	63	11	31	73	436
Flavobacterium		Bacteria	105	93	97	121	117	0
Geobacter		Bacteria	40	69	179	128	98	11
Synchaeta		Rotifers	315	16	0	28	123	0
Polynucleobacter		Bacteria	52	82	0	133	84	55
Dechloromonas		Bacteria	31	43	163	98	31	7
Ideonella		Bacteria	84	109	0	77	65	0
Ferruginibacter		Bacteria	33	64	88	98	43	0
Stylonychia		Ciliates	0	0	0	33	281	0
Ligustrum	Privets	Plants	17	46	20	63	149	0
Nocardioides		Bacteria	55	96	0	0	134	0
Cosmarium		Other	11	0	0	0	0	261
Potamopyrgus	Mud snails	Molluscs	0	56	69	76	67	0
Sideroxydans		Bacteria	85	88	40	41	12	0
Methylobacterium		Bacteria	84	94	19	0	63	0
Prunus	Prunus	Plants	0	0	215	0	0	38

Turdus	Thrush	Birds	0	0	226	19	0	8
Stentor		Ciliates	39	49	0	100	50	0
Polaromonas		Bacteria	110	46	0	0	66	14
Methylomonas		Bacteria	55	0	170	0	0	0
Ferribacterium		Bacteria	40	45	41	66	32	0
Lepocinclis		Other	37	75	0	41	59	0
Eucyclops	Copepod	Crustaceans	12	6	0	145	40	0
Reyranella		Bacteria	46	18	22	96	21	0
Rumex	Docks; sorrels	Plants	27	101	22	0	24	28
Alnus	Alder	Plants	21	138	0	7	10	17
Quercus	Oaks	Plants	12	40	0	23	71	33
Veronica subgen. Beccabunga		Plants	0	0	0	178	0	0
Parisotoma	Springtail	Springtails	0	0	0	0	0	177
Mucilaginibacter		Bacteria	84	23	0	18	44	7
Microdalyellia		Flatworms	6	0	167	0	0	0
Chamaedrilus	Worm	Worms	0	6	0	11	151	0
Sphingomonas		Bacteria	90	17	0	34	14	0
Prostoma		Other	99	0	15	19	20	0
Rhodoblastus		Bacteria	0	0	61	0	58	31
Candidatus Solibacter		Bacteria	0	26	36	82	0	0
Geothrix		Bacteria	38	39	0	44	22	0
Pseudolabrys		Bacteria	0	39	58	46	0	0
Neourostylopsis		Ciliates	35	0	103	0	0	0
Crataegus	Hawthorn	Plants	60	41	0	13	18	0
Anguilla	Eels	Fish	48	81	0	0	0	0
Capnobotryella		Fungi	0	124	0	0	0	0
Georgfuchsia		Bacteria	19	60	12	24	0	0
Rubus	Bramble	Plants	0	18	94	0	0	0
Ilyodrilus	Worm	Worms	0	0	0	0	112	0
Methylovorus		Bacteria	77	0	0	0	33	0
Filinia		Rotifers	0	80	0	0	0	20
Chloromonas	Green algae	Green algae	9	0	0	64	8	18
Cellvibrio		Bacteria	28	18	43	9	0	0

Rhodobacter		Bacteria	9	0	17	53	6	0
Gunnera		Plants	0	57	0	28	0	0
Acer	Maple	Plants	0	0	82	0	0	0
Halteria		Ciliates	82	0	0	0	0	0
Methylobacter		Bacteria	0	0	0	0	27	54
Microlunatus		Bacteria	41	0	0	0	35	0
Ulex	Gorses	Plants	75	0	0	0	0	0
Phialina	Ciliate	Ciliates	19	37	0	0	18	0
Paludibacter		Bacteria	18	22	20	0	5	6
Chryseolinea		Bacteria	15	11	21	23	0	0
Siccationidurans		Bacteria	29	16	0	0	24	0
Dero	Worm	Worms	0	8	0	41	0	18
Labilithrix		Bacteria	0	0	0	67	0	0
Cochliopodium	Amoeba	Amoebae	9	8	0	33	16	0
Microbacterium		Bacteria	0	19	23	0	21	0
Roseiarcus		Bacteria	0	0	0	27	35	0
Galium	Bedstraw	Plants	23	17	0	0	0	19
Aquicella		Bacteria	29	29	0	0	0	0
Pseudomonas		Bacteria	29	0	0	28	0	0
Styrax		Plants	0	0	56	0	0	0
Paspalum	Paspalums; Bahiagrasses; Crowngrasse	Plants	12	0	24	0	0	18
Poa	Bluegrass	Plants	0	52	0	0	0	0
Porcellio		Crustaceans	0	6	45	0	0	0
Alocasia		Plants	0	27	0	0	0	22
Barranca	Green alga	Green algae	49	0	0	0	0	0
Cetobacterium		Bacteria	13	17	4	14	0	0
Triplectides	NZ caddisfly	Insects	0	47	0	0	0	0
Telmatobacter		Bacteria	20	0	0	0	27	0
Neobodo		Other	0	25	0	19	0	0
Allium		Plants	0	16	0	0	26	0
Gomphonema	Diatom	Diatoms	5	0	35	0	0	0
Limnophyes	Non-biting midge	Insects	0	5	0	0	5	30
Tokophrya		Ciliates	0	0	0	0	39	0

Carduelis	Greenfinch or goldfinch	Birds	0	6	0	0	32	0
Elachista		Insects	38	0	0	0	0	0
Cornus	Dogwoods	Plants	0	0	0	12	25	0
Achlya		Oomycetes	10	0	0	27	0	0
Syntrophorhabdus		Bacteria	28	0	0	0	9	0
Sorodiplophrys		Heterokont a	15	9	13	0	0	0
Plantago	Plaintains; fleaworts	Plants	0	0	0	0	8	28
Pittosporum		Plants	0	0	0	0	0	32
Prosthecobacter		Bacteria	0	0	0	6	26	0
Spirosoma		Bacteria	9	16	0	0	0	6
Glycine		Plants	7	0	0	0	11	13
Cura		Flatworms	17	9	0	0	5	0
Glyceria	Mannagrasses; sweet-grasses	Plants	0	0	16	13	0	0
Aeromonas		Bacteria	0	11	0	16	0	0
Clostridium		Bacteria	0	12	0	0	7	8
Magnolia		Plants	0	0	0	0	0	27
Octolasion	Worm	Worms	0	0	0	6	20	0
Opogona	Fungus moth	Insects	0	0	26	0	0	0
Aquihabitans		Bacteria	0	26	0	0	0	0
Podocarpus	Conifers	Plants	0	0	25	0	0	0
Pinnularia	Freshwater diatom	Diatoms	18	7	0	0	0	0
Notholca		Rotifers	0	18	0	0	0	7
Ectopsocus	Psocopteran fly	Insects	0	0	0	0	19	5
Chthoniobacter		Bacteria	0	0	0	24	0	0
Macromonas		Bacteria	23	0	0	0	0	0
Prevotella		Bacteria	9	6	0	0	7	0
Hymenobacter		Bacteria	11	0	0	0	11	0
Candidatus Udaeobacter		Bacteria	0	5	0	17	0	0
Syntrophobacter		Bacteria	0	13	0	8	0	0
Brassica		Plants	0	0	0	0	20	0
Juncus	Rushes	Plants	8	4	8	0	0	0
Sinantherina		Rotifers	0	0	12	0	8	0
Pristina	Worm	Worms	0	11	0	4	5	0

Pontixanthobacter		Bacteria	0	0	0	20	0	0
Singulisphaera		Bacteria	0	19	0	0	0	0
Euphorbia	Spurge	Plants	0	0	0	0	18	0
Thermomonas		Bacteria	0	18	0	0	0	0
Sulfuricurvum		Bacteria	0	0	4	8	6	0
Polygonum		Plants	0	0	0	16	0	0
Tricladium		Fungi	16	0	0	0	0	0
Ruminiclostridium		Bacteria	0	0	16	0	0	0
Pirellula		Bacteria	0	0	0	0	15	0
Carex	Sedges	Plants	0	0	0	15	0	0
Roseomonas		Bacteria	0	0	0	0	0	15
Pedomicrobium		Bacteria	0	0	0	0	14	0
Amynthas	Worm	Worms	0	0	9	0	5	0
Paludibaculum		Bacteria	9	5	0	0	0	0
Acinetobacter		Bacteria	0	13	0	0	0	0
Thiocystis		Bacteria	13	0	0	0	0	0
Plumatella	Plumatella	Bryozoans	0	0	0	0	13	0
Arcicella		Bacteria	0	9	0	0	0	4
Vanrija		Fungi	0	0	13	0	0	0
Flectobacillus		Bacteria	0	0	12	0	0	0
Tubifex	Worm	Worms	12	0	0	0	0	0
Surirella	Diatom	Diatoms	12	0	0	0	0	0
Flavisolibacter		Bacteria	0	0	0	12	0	0
Cutibacterium		Bacteria	0	0	0	0	12	0
Blepharisma		Ciliates	0	0	0	0	11	0
Potentilla		Plants	11	0	0	0	0	0
Aporrectodea	Worm	Worms	5	6	0	0	0	0
Salpingoeca		Other	0	0	11	0	0	0
Arenimonas		Bacteria	0	0	11	0	0	0
Zoogloea		Bacteria	0	0	0	0	0	10
Stenostomum	Freshwater catenulid flatworm	Flatworms	0	6	0	0	4	0
Devosia		Bacteria	0	0	0	10	0	0
Aureimonas		Bacteria	0	0	0	0	10	0

Phytophthora	Water mold	Oomycetes	9	0	0	0	0	0
Cryptoglena		Other	0	0	0	9	0	0
Chironomus		Insects	9	0	0	0	0	0
Zavarzinella		Bacteria	0	0	0	9	0	0
Jasminum	Jasmine	Plants	0	0	0	0	0	8
Lumbriculus	Worm	Worms	8	0	0	0	0	0
Psilochorema	Endemic NZ caddisfly	Insects	8	0	0	0	0	0
Pseudoeconesus		Insects	0	0	8	0	0	0
Arcitalitrus		Crustaceans	0	0	8	0	0	0
Amblystegium	Feather moss	Mosses	0	0	0	0	0	7
Alistipes		Bacteria	7	0	0	0	0	0
Megalothorax	Springtail	Springtails	0	0	0	7	0	0
Thiothrix		Bacteria	6	0	0	0	0	0
Corynebacterium		Bacteria	0	0	0	0	6	0
Canna		Plants	0	6	0	0	0	0
Melampsora		Fungi	0	0	6	0	0	0
Passer	Sparrow	Birds	0	0	0	6	0	0
Erodium		Plants	6	0	0	0	0	0
Sphaerium		Molluscs	0	0	0	0	6	0
Pelobacter		Bacteria	0	0	5	0	0	0
Cytophaga		Bacteria	0	0	0	0	5	0
Euglena		Other	5	0	0	0	0	0
Zosterops	White eye	Birds	0	0	5	0	0	0
Hanseniella		Other	0	5	0	0	0	0
Phacus		Other	0	0	0	5	0	0
Cadophora		Fungi	5	0	0	0	0	0
Dehalogenimonas		Bacteria	0	0	5	0	0	0
Megascolex	Worm	Worms	0	0	0	0	5	0
Planctomicrobium		Bacteria	0	5	0	0	0	0
Nitzschia	Pennate diatom	Diatoms	0	0	4	0	0	0
Viola		Plants	0	0	0	0	0	4
Philaenus		Insects	0	0	4	0	0	0
Buchnera	Aphid P-endosymbionts	Bacteria	0	4	0	0	0	0

Frontonia		Ciliates	0	0	0	0	4	0
Austropallene		Other	0	4	0	0	0	0
Spongomonas		Other	4	0	0	0	0	0
Korotnevella	Amoeba	Amoebae	4	0	0	0	0	0
Thecamoeba		Amoebae	4	0	0	0	0	0
Rhodoluna		Bacteria	4	0	0	0	0	0
Mermessus		Spiders	0	0	0	0	4	0
Eiseniella	Worm	Worms	0	0	0	4	0	0
Mallomonadaceae		Heterokont a	519	1042	0	714	575	731
Cyclopidae		Crustaceans	607	1020	0	321	439	263
Lamiaceae	Mint family	Plants	142	284	0	141	1096	38
Poaceae	Grass family	Plants	28	17	0	940	79	331
Tintinnidae		Ciliates	104	244	0	112	518	0
Chitinophagaceae		Bacteria	159	88	252	222	137	48
Podocarpaceae		Plants	366	404	0	0	35	26
Strobilidiidae		Ciliates	68	46	626	0	39	8
Stentoridae		Ciliates	10	53	73	46	484	0
Araliaceae	Ginseng family	Plants	40	222	161	197	0	15
Holostichidae	Ciliates	Ciliates	125	223	176	28	81	0
Cryptomonadaceae		Cryptomona(	117	115	0	156	16	134
Chaetonotidae		Other	61	129	226	21	15	11
Chilodonellidae		Ciliates	0	0	0	0	0	423
Caulobacteraceae		Bacteria	115	85	22	76	91	27
Bradyrhizobiaceae		Bacteria	120	68	69	47	101	0
Acetobacteraceae		Bacteria	77	168	0	97	57	0
Solibacteraceae		Bacteria	70	25	33	41	108	0
Asteraceae	Daisy family	Plants	26	49	0	139	51	0
Acidobacteriaceae		Bacteria	64	116	9	34	37	0
Synchaetidae		Rotifers	0	14	0	47	38	158
Pooideae		Plants	21	25	0	0	164	42
Rhodobacteraceae		Bacteria	16	18	72	66	35	42
Oxytrichidae		Ciliates	0	0	63	0	0	186
Chloridoideae		Plants	24	75	0	12	11	116

Micrairoideae		Plants	20	0	100	29	81	0
Chydoridae		Crustaceans	0	0	214	0	0	0
Musaceae	Banana family	Plants	0	12	0	0	125	70
Methylophilaceae		Bacteria	0	0	64	113	30	0
Cytophagaceae		Bacteria	56	37	8	34	53	0
Fabaceae	Pea family	Plants	52	14	0	82	5	20
Berberidoideae		Plants	41	0	0	22	110	0
Pyrenomonadaceae		Cryptomonad	0	93	0	5	5	60
Fagaceae	Beech family	Plants	20	0	0	21	82	22
Rosoideae		Plants	8	6	88	8	24	0
Flavobacteriaceae		Bacteria	0	0	70	0	24	38
Thigmophryidae		Ciliates	0	16	71	13	26	0
Araceae	Arum family	Plants	91	31	0	0	0	0
Mycobacteriaceae		Bacteria	35	35	0	7	25	18
Pirellulaceae		Bacteria	0	19	0	82	11	0
Convolvulaceae	Morning-glory family	Plants	53	29	0	0	20	0
Litonotidae	Ciliates	Ciliates	12	14	68	6	0	0
Euplotidae		Ciliates	0	43	51	0	5	0
Tetrahymenidae		Ciliates	0	0	70	27	0	0
Thoracosphaeraceae		Dinoflagellat	0	13	0	83	0	0
Prolixibacteraceae		Bacteria	0	11	63	21	0	0
Spirochaetaceae		Bacteria	37	11	28	0	18	0
Reichenbachiellaceae		Bacteria	39	14	22	19	0	0
Myrtoideae		Plants	10	0	83	0	0	0
Sterolibacteriaceae		Bacteria	0	0	62	16	14	0
Intrasporangiaceae		Bacteria	68	0	0	0	21	0
Cupressaceae	Cypress family	Plants	0	9	0	11	61	4
Oscillospiraceae		Bacteria	0	0	32	34	18	0
Micromonosporaceae		Bacteria	35	36	0	0	0	12
Chaetophoraceae		Green algae	83	0	0	0	0	0
Euglenaceae		Other	4	17	0	47	7	4
Gemmataceae		Bacteria	7	40	29	0	0	0
Juglandaceae	Walnut family	Plants	9	19	0	0	32	15

Asparagaceae	Asparagus family	Plants	0	0	0	0	26	49
Isosphaeraceae		Bacteria	10	20	0	25	20	0
Solanaceae	Nightshade family	Plants	0	0	0	8	27	37
Lumbriculidae		Worms	41	17	0	0	14	0
Solanoideae		Plants	0	0	0	31	0	40
Daphniidae		Crustaceans	0	0	0	0	0	69
Entomobryoidea		Springtails	66	0	0	0	0	0
Geodermatophilaceae		Bacteria	28	0	0	0	30	0
Athyriaceae		Plants	33	0	8	17	0	0
Polygonoideae		Plants	0	17	23	0	17	0
Planctomycetaceae		Bacteria	0	27	0	6	20	0
Legionellaceae		Bacteria	32	0	0	0	19	0
Desulfobacteraceae		Bacteria	16	0	28	0	7	0
Cyatheaceae		Plants	0	0	0	0	49	0
Betulaceae	Birch family	Plants	15	0	0	0	32	0
Holophagaceae		Bacteria	0	0	45	0	0	0
Desulfobulbaceae		Bacteria	16	7	20	0	0	0
Chlamydomonadaceae		Green algae	0	6	0	30	0	5
Crocinitomicaceae		Bacteria	5	0	6	10	4	16
Bryobacteraceae		Bacteria	0	4	10	27	0	0
Devosiaceae		Bacteria	0	0	41	0	0	0
Aroideae		Plants	0	0	0	16	0	23
Naidinae	Sludgeworms	Worms	0	29	10	0	0	0
Amphileptidae		Ciliates	37	0	0	0	0	0
Hyphomicrobiaceae		Bacteria	36	0	0	0	0	0
Syntrophobacteraceae		Bacteria	23	0	13	0	0	0
Anaeromyxobacteraceae		Bacteria	0	0	15	21	0	0
Steroidobacteraceae		Bacteria	22	0	13	0	0	0
Oxalobacteraceae		Bacteria	23	0	11	0	0	0
Dugesiidae		Flatworms	9	8	10	0	6	0
Microbacteriaceae		Bacteria	0	0	0	0	33	0
Rhodanobacteraceae		Bacteria	21	12	0	0	0	0
Azonexaceae		Bacteria	0	0	10	23	0	0

Buellioideae		Fungi	0	32	0	0	0	0
Scenedesmaceae		Green algae	0	0	0	0	15	16
Reyranellaceae		Bacteria	0	0	20	0	11	0
Lauraceae	Laurel family	Plants	0	0	0	0	14	16
Lamioideae		Plants	0	0	30	0	0	0
Rhodocyclaceae		Bacteria	10	0	0	17	0	0
Nocardioidaceae		Bacteria	27	0	0	0	0	0
Alcaligenaceae		Bacteria	0	0	0	9	0	17
Rubioideae		Plants	0	0	26	0	0	0
Eubacteriales Family XIII. Incertae Sedis		Bacteria	5	8	6	0	7	0
Pythiaceae	Water moulds	Oomycetes	25	0	0	0	0	0
Beijerinckiaceae		Bacteria	0	25	0	0	0	0
Bacteroidaceae		Bacteria	9	8	0	7	0	0
Chenopodioideae		Plants	8	0	0	0	16	0
Carduelinae		Birds	0	0	0	18	5	0
Panicoideae		Plants	0	0	0	0	0	23
Sturnidae	Starlings	Birds	8	0	0	0	14	0
Chytriomycetaceae	Chytrid fungi	Fungi	0	0	0	22	0	0
Prevotellaceae		Bacteria	0	4	0	0	13	4
Saprolegniaceae		Oomycetes	13	0	0	0	0	7
Rhizobiaceae		Bacteria	0	0	20	0	0	0
Lachnospiraceae		Bacteria	0	0	0	0	20	0
Peronosporaceae		Oomycetes	0	0	19	0	0	0
Vorticellidae		Ciliates	12	0	0	0	0	6
Brassicaceae	Mustard family	Plants	0	17	0	0	0	0
Tokophryidae		Ciliates	0	16	0	0	0	0
Tateidae	Aquatic snails	Molluscs	0	0	16	0	0	0
Bacillaceae		Bacteria	15	0	0	0	0	0
Lembadionidae		Ciliates	15	0	0	0	0	0
Sympoventuriaceae		Fungi	0	0	0	15	0	0
Cyperaceae	Sedge family	Plants	0	0	0	0	0	14
Anatidae	Ducks/Geese/Swan	Birds	0	14	0	0	0	0
Rutaceae	Rue family	Plants	0	0	0	0	0	14

Thiovulaceae		Bacteria	8	0	0	6	0	0
Thermodesulfovibrionaceae		Bacteria	0	14	0	0	0	0
Megascolecidae		Worms	0	0	0	13	0	0
Protomycetaceae		Fungi	13	0	0	0	0	0
Spongomonadidae		Other	0	4	0	9	0	0
Rhynchomonadidae		Other	0	0	13	0	0	0
Nitrospiraceae		Bacteria	7	0	0	5	0	0
Naididae	Sludgeworms	Worms	0	0	7	5	0	0
Plasmodiophoridae	Plasmodiophorids	Other	0	5	6	0	0	0
Saprospiraceae		Bacteria	0	0	11	0	0	0
Actinochloridaceae		Green algae	0	0	10	0	0	0
Rikenellaceae		Bacteria	0	10	0	0	0	0
Sphingomonadaceae		Bacteria	0	9	0	0	0	0
Fragilariaceae		Diatoms	0	0	0	0	4	4
Naviculaceae		Diatoms	0	8	0	0	0	0
Amygdaloideae		Plants	0	0	8	0	0	0
Oligoflexaceae		Bacteria	0	0	0	4	4	0
Coxiellaceae		Bacteria	0	0	7	0	0	0
Placidae		Ciliates	0	0	0	0	7	0
Haliscomenobacteraceae		Bacteria	0	0	0	0	0	7
Paludibacteraceae		Bacteria	0	7	0	0	0	0
Kaistiaceae		Bacteria	7	0	0	0	0	0
Epistylidae		Ciliates	6	0	0	0	0	0
Clostridiaceae		Bacteria	0	0	0	0	0	5
Lactobacillaceae		Bacteria	0	0	0	0	5	0
Salpingoecidae		Other	0	0	0	5	0	0
Deinococcaceae		Bacteria	0	0	0	0	4	0
Pavlovaceae		Other	0	0	0	4	0	0
Phacaceae		Other	4	0	0	0	0	0
Oedogoniaceae		Green algae	4	0	0	0	0	0
root		Other	10791	11564	18660	20105	15782	15147
Metazoa	Metazoans	Other	4841	3280	21447	3327	6725	37314
Arthropoda	Arthropods	Other	601	54	6939	26	66	13

Betaproteobacteria		Bacteria	501	350	397	904	303	92
Gammaproteobacteria		Bacteria	402	372	643	642	382	58
Spirotrichea		Ciliates	104	190	756	70	711	514
Burkholderiales		Bacteria	561	446	358	544	235	91
Ciliophora	Ciliates	Other	665	411	739	56	128	93
Chordata	Chordates	Other	15	495	16	793	258	9
Trematoda	Flukes	Flatworms	72	119	1201	116	66	0
Bacteroidetes	Bacteroides-Cytophaga-Flexibacter gr	Bacteria	157	230	435	346	170	62
Haptorida		Ciliates	44	83	632	204	360	0
Saliceae		Plants	0	0	0	0	1080	144
Embryophyta	Higher plants	Other	239	386	66	110	398	0
Hyphomicrobiales		Bacteria	280	302	53	274	254	13
Tintinnida		Ciliates	162	271	0	161	551	0
Alphaproteobacteria		Bacteria	206	179	148	362	164	40
Proteobacteria	Purple bacteria and relatives	Bacteria	274	177	166	257	180	13
asterids		Plants	20	56	0	555	348	0
Fungi		Other	220	120	173	268	145	0
Chrysophyceae	Chrysomonads	Heterokont a	70	86	15	190	129	348
Insecta	Insects	Other	0	13	767	8	15	13
Poales		Plants	281	108	0	102	134	78
Armophorea		Ciliates	234	332	25	14	97	0
Desulfuromonadales		Bacteria	167	95	224	173	41	0
Burkholderiales genera incertae sedis		Bacteria	104	152	106	175	120	23
Spumella-like flagellate JB		Heterokont a	33	81	0	45	69	381
Eukaryota	Eucaryotes	Other	42	118	61	18	18	348
Cytophagia		Bacteria	70	76	147	113	98	0
Mesangiospermae		Plants	124	177	176	0	11	0
Cryptomonadales		Cryptomona	65	69	0	213	40	81
fabids		Plants	0	0	380	0	0	48
Nitrosomonadales		Bacteria	85	136	90	0	104	0
Chlorophyta	Green algae	Other	154	64	11	68	11	95
Cryptophyceae	Cryptomonads	Other	69	56	0	165	24	65
Poeae		Plants	0	18	18	317	25	0

Malpighiales		Plants	0	20	245	0	80	0
Mammalia	Mammals	Other	138	195	0	0	0	0
Actinobacteria		Bacteria	39	25	51	49	112	18
Planctomycetia		Bacteria	28	52	43	76	74	16
Diplostraca		Crustaceans	0	0	286	0	0	0
Planctomycetes		Bacteria	27	45	46	66	75	6
Anthemideae		Plants	0	0	0	257	0	0
Myxococcales	Fruiting gliding bacteria	Bacteria	27	39	0	153	33	0
Firmicutes	Low GC Gram+	Bacteria	71	120	4	8	31	16
Gastropoda	Gastropods	Molluscs	82	66	59	0	26	0
unclassified Stenostomum (in: Platyhelm		Flatworms	0	207	0	0	0	0
Chlamydiae		Bacteria	62	37	39	0	47	0
Passeriformes	Song birds	Birds	0	0	0	117	52	0
Chlorophyceae		Green algae	0	0	0	137	0	30
Actinomycetia	High G+C Gram-positive bacteria	Bacteria	0	26	62	26	52	0
Kinetoplastea	Kinetoplastids	Other	30	26	36	56	17	0
Lecanoromycetes		Fungi	73	0	0	0	73	14
Stichotrichia		Ciliates	0	0	159	0	0	0
Cercozoa		Other	31	38	14	39	17	17
Dinophyceae	Dinoflagellates	Other	29	61	0	64	0	0
Rosales		Plants	56	58	0	17	11	0
Ascomycota	Ascomycetes	Fungi	17	119	0	6	0	0
Eurotatoria		Rotifers	91	13	30	0	4	0
Viridiplantae	Green plants	Other	12	12	0	4	10	98
Chytridiomycota		Fungi	6	22	10	58	0	34
Lamiales		Plants	0	0	0	126	0	0
Philasterida		Ciliates	0	0	102	24	0	0
Hexanauplia		Crustaceans	0	77	0	45	0	0
Deltaproteobacteria		Bacteria	7	27	84	0	0	0
Metopida		Ciliates	0	0	108	0	0	0
Oomycota		Heterokont a	6	19	18	21	14	12
Eubacteriales		Bacteria	7	28	21	18	14	0
Loteae		Plants	0	0	35	0	45	5

Trebouxiophyceae		Green algae	5	56	0	0	7	16
Alsineae		Plants	6	0	0	36	29	9
Magnoliopsida	Angiosperms	Plants	8	18	0	0	4	48
Zingiberales		Plants	12	0	0	0	15	48
Pirellulales		Bacteria	4	4	20	17	28	0
Nitrospirae		Bacteria	0	0	23	46	0	0
unclassified Enchelyodon		Ciliates	0	0	65	0	0	0
Jasmineae		Plants	0	0	0	0	0	64
Litostomatea		Ciliates	44	14	0	0	5	0
Bacillales		Bacteria	0	56	0	0	6	0
Chlamydomonadales		Green algae	0	0	0	9	9	43
Branchiopoda		Crustaceans	0	0	0	0	0	57
Pleosporales		Fungi	35	0	16	0	0	0
Bacillariophyta	Diatoms	Heterokont a	0	0	50	0	0	0
Chromulinales		Heterokont a	0	24	0	0	22	0
Asparagales		Plants	0	0	0	0	6	36
Nassophorea		Ciliates	0	0	41	0	0	0
Chaetothyriales	Black yeasts	Fungi	0	39	0	0	0	0
Oligohymenophorea		Ciliates	0	0	37	0	0	0
Sorangiineae		Bacteria	0	36	0	0	0	0
Neobodonida		Other	24	0	12	0	0	0
Caryophyllales		Plants	0	10	0	0	10	15
Amphifilida		Heterokont a	0	10	14	0	11	0
Diptera	Flies	Insects	33	0	0	0	0	0
Gemmatales		Bacteria	0	0	33	0	0	0
Legionellales		Bacteria	0	0	0	0	32	0
Micrococcales		Bacteria	19	0	0	0	11	0
Annelida	Annelid worms	Other	18	0	0	4	7	0
Verrucomicrobia		Bacteria	0	0	0	0	17	11
Synhymeniida		Ciliates	0	0	28	0	0	0
Thecofilosea		Other	0	27	0	0	0	0
Mucoromycota		Fungi	27	0	0	0	0	0
Cryptomycota incertae sedis		Fungi	8	14	0	0	4	0

Acidobacteria		Bacteria	0	0	25	0	0	0
Xanthomonadales		Bacteria	0	0	14	0	11	0
Clostridia		Bacteria	0	7	18	0	0	0
Bilateria		Other	24	0	0	0	0	0
Gastrotricha	Gastrotrichs	Other	0	0	24	0	0	0
Bacillariophyceae	Raphid, pennate diatoms	Diatoms	16	0	4	4	0	0
Sphingomonadales		Bacteria	0	0	6	0	18	0
Lepidoptera	Butterflies and moths	Insects	0	20	0	0	0	0
Cenchrinae		Plants	20	0	0	0	0	0
Brassiceae		Plants	0	19	0	0	0	0
Saccharomycetales		Fungi	0	18	0	0	0	0
Clitellata		Worms	0	18	0	0	0	0
Asterales		Plants	0	0	0	17	0	0
Myrtales		Plants	0	0	17	0	0	0
Ploima		Rotifers	0	0	0	17	0	0
Euglenales		Other	0	17	0	0	0	0
Enterobacterales		Bacteria	4	0	4	0	9	0
cellular organisms		Other	0	0	0	16	0	0
Lactobacillales		Bacteria	0	0	0	0	11	5
Pentapetalae		Plants	0	0	0	0	0	16
Bigyra		Heterokont a	0	0	16	0	0	0
Astomatida		Ciliates	0	15	0	0	0	0
Xanthophyceae	Yellow-green algae	Heterokont a	14	0	0	0	0	0
Aves	Birds	Other	6	0	0	8	0	0
Ulotrichales		Green algae	5	9	0	0	0	0
Eumycetozoa		Amoebae	6	8	0	0	0	0
Rhodobacterales		Bacteria	0	14	0	0	0	0
Trypanosomatida		Other	0	0	14	0	0	0
Bacteroidales		Bacteria	0	0	0	13	0	0
Amphipoda	Amphipods	Crustaceans	4	7	0	0	0	0
campanulids		Plants	0	0	0	0	0	11
Colocasieae		Plants	0	0	0	0	0	11
Selenomonadales		Bacteria	0	11	0	0	0	0

Luna-1 subcluster		Bacteria	0	0	0	6	5	0
Rhizobium/Agrobacterium group		Bacteria	0	0	0	0	10	0
Aceriini		Mites and tic	9	0	0	0	0	0
Tribonematales		Heterokont a	8	0	0	0	0	0
Rotifera	Rotifers	Other	0	0	0	0	8	0
Chromadorea		Other	0	0	4	0	4	0
Pleurostomatida		Ciliates	0	0	8	0	0	0
unclassified Frontoniidae		Ciliates	8	0	0	0	0	0
Euglenozoa		Other	0	0	0	7	0	0
Bdelloidea		Rotifers	7	0	0	0	0	0
Crepidinae		Plants	0	0	0	0	7	0
Conoidasida		Other	0	0	7	0	0	0
Imbricatea		Other	0	0	7	0	0	0
Tepidisphaerales		Bacteria	0	0	0	7	0	0
Haptista		Other	0	7	0	0	0	0
Euphyllophyta		Plants	6	0	0	0	0	0
Chloroflexi	Green non-sulfur bacteria	Bacteria	0	0	0	0	6	0
Chytridiomycetes		Fungi	0	0	6	0	0	0
Entomobryomorpha		Springtails	0	0	0	0	0	6
Cryptomycota		Fungi	0	6	0	0	0	0
Plagiopylida		Ciliates	0	0	6	0	0	0
unclassified Vaginicola		Ciliates	0	0	6	0	0	0
Basidiomycota	Basidiomycetes	Fungi	5	0	0	0	0	0
Venerida		Molluscs	0	0	5	0	0	0
Trichoptera	Caddisflies	Insects	0	0	5	0	0	0
Bacilli		Bacteria	0	0	0	0	0	5
Euglyphida		Other	0	0	0	5	0	0
Thaumatomonadida		Other	0	0	0	5	0	0
Flavobacteriales		Bacteria	5	0	0	0	0	0
Helicina		Molluscs	0	5	0	0	0	0
Phycisphaerae		Bacteria	0	0	0	5	0	0
Poduromorpha		Springtails	0	5	0	0	0	0
unclassified Trentepohlia		Green algae	5	0	0	0	0	0

Bryopsida		Mosses	0	0	0	4	0	0
Araneae	Spiders	Other	4	0	0	0	0	0
Rhabdocoela		Flatworms	0	4	0	0	0	0
Pavlovales		Other	0	0	0	4	0	0
Euthyneura		Molluscs	0	0	4	0	0	0
Thaumarchaeota		Archaea	0	0	0	0	4	0
Sessilida		Ciliates	4	0	0	0	0	0
unclassified Paraphysomonas		Heterokont a	0	0	0	4	0	0

APPENDIX E LABORATORY WATER QUALITY DATA

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Certificate of Analysis

Client:	BTW Company Ltd - Hamilton Branch	**Lab No:**	3039802 SPv1
Contact:	Alice Wheatley-Wilson	**Date Received:**	22-Jul-2022
	C/- BTW Company Ltd - Hamilton Branch	**Date Reported:**	29-Jul-2022
	PO Box 551	**Quote No:**	116942
	New Plymouth 4340	**Order No:**	
		Client Reference:	211365
		Submitted By:	Alice Wheatley-Wilson

Sample Type: Aqueous

Sample Name:		Endsite_1 22-Jul-2022 10:15 am	WL4_2 22-Jul-2022 10:45 am	WL7_3 22-Jul-2022 11:30 am	WL8_4 22-Jul-2022 12:00 pm	WL13_5 22-Jul-2022 12:15 pm
Lab Number:		3039802.1	3039802.2	3039802.3	3039802.4	3039802.5
Total Nitrogen	g/m^3	1.80	1.19	4.5	1.26	1.20
Total Ammoniacal-N	g/m^3	0.013	< 0.010	0.023	< 0.010	< 0.010
Nitrite-N	g/m^3	0.003	0.003	0.005	0.004	0.004
Nitrate-N	g/m^3	1.56	0.91	2.9	1.01	1.01
Nitrate-N + Nitrite-N	g/m^3	1.56	0.92	2.9	1.01	1.02
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.24	0.27	1.56	0.25	0.19
Dissolved Reactive Phosphorus	g/m^3	0.006	< 0.004	< 0.004	< 0.004	0.004
Total Phosphorus	g/m^3	0.026	0.032	0.188	0.036	0.022

Sample Name:		Pond_6 22-Jul-2022 12:45 pm
Lab Number:		3039802.6
Total Nitrogen	g/m^3	1.40
Total Ammoniacal-N	g/m^3	< 0.010
Nitrite-N	g/m^3	0.009
Nitrate-N	g/m^3	0.64
Nitrate-N + Nitrite-N	g/m^3	0.65
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.75
Dissolved Reactive Phosphorus	g/m^3	< 0.004
Total Phosphorus	g/m^3	0.075

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-6
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-6
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) 23rd ed. 2017.	0.010 g/m^3	1-6
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) 23rd ed. 2017.	0.002 g/m^3	1-6
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N. In-House.	0.0010 g/m^3	1-6
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) 23rd ed. 2017.	0.002 g/m^3	1-6

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) 23^{rd} ed. 2017.	0.10 g/m^3	1-6
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) 23^{rd} ed. 2017.	0.004 g/m^3	1-6
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) 23^{rd} ed. 2017.	0.002 g/m^3	1-6

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 26-Jul-2022 and 29-Jul-2022. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Martin Cowell - BSc
Client Services Manager - Environmental

APPENDIX F ASSESSMENT AND EFFECTS METHODOLOGY

Table F 2: Assigning value to terrestrial species, sites or areas, adapted from the EIANZ Guidelines Tables 5 & 6

Ecological Value	Determining Factors for Terrestrial Species	Determining Factors for Terrestrial Site or Area
Very High	Nationally Threatened species, found in the ZOI either permanently or seasonally	Area rates High for 3 or all of the four assessment matters listed in Table 4. Likely to be nationally important and recognised as such.
High	Species listed as At Risk – Declining, found in the ZOI, either permanently or seasonally	Area rates High for 2 of the assessment matters, Moderate and Low for the remainder, or Area rates High for 1 of the assessment maters, Moderate for the remainder. Likely to be regionally important and recognised as such.
Moderate	Species listed as any other category of At Risk, found in the ZOI either permanently or seasonally, or Locally (ED) uncommon or distinctive species	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 Likely to be important at the level of the Ecological District.
Low	Nationally and locally common indigenous species	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	Exotic species, including pests, species having recreational value	Area rates Very Low for 3 matters and Moderate, Low or Very Low for remainder.

Table F 3: Criteria for describing magnitude of effect, adapted from the EIANZ Guidelines Table 8

Ecological Value	Description
Very High	Total loss of, or very major alteration to, key elements/features/ of the existing baseline conditions, such that the post-development character, composition and/or attributes will be fundamentally changed and may be lost from the site altogether; AND/OR Loss of a very high proportion of the known 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

Table F 4: Criteria for describing level of effect, adapted from the EIANZ Guidelines Table 10

Ecological Value Magnitude	Very High	High	Moderate	Low	Negligible
Very High	Very High	Very High	High	Moderate	Low
High	Very High	Very High	Moderate	Low	Very Low
Moderate	High	High	Moderate	Low	Very Low
Low	Moderate	Low	Low	Very Low	Very Low
Negligible	Low	Very Low	Very Low	Very Low	Very Low
Positive	Net Gain	Net Gain	Net Gain	Net Gain	Net Gain