Summary of Findings - Pudding Hill Stock Water Race Network (Ecological Snapshot)

Report

Prepared for Ashburton District Council
Prepared by Beca Limited

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Contents

Appendices

Revision History

Revision N°	Prepared By	Description	Date
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Action	Name	Signed	Date
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on behalf of	Beca Limited		

Executive Summary

Beca Limited (Beca) were commissioned by Ashburton District Council (ADC) to prepare a Summary of Findings report for the set of field assessments carried out as part of a wider assessment of ecological value within the Pudding Hill stock water race network. This work is to support an investigation into the closure of the Pudding Hill stock water race network.

This snapshot assessment of potential ecological value seeks to provide a high-level summary of characteristics and identify differences across the Pudding Hill stockwater network. The race network (largely) is not comprised of 'natural streams' under the Resource Management Act (RMA) definition, therefore, this assessment has been conducted to check what ecological values may be present in this artificial network as it stands.

Existing Information

There is limited existing ecological information for the Pudding Hill stockwater network. Opus (now WSP) undertook an assessment of the entire ADC stockwater network in 2014 and concluded that across 20 sample sites (noting that none of these sites were within the Pudding Hill network) there were a mixture of high, medium to high, and low potential ecological values across the race network. These classifications were primarily driven by the relative abundance of suitable Canterbury Mudfish habitat (a Threatened - Nationally Critical species) and/or the presence of other native fish species.

In 2022, Environment Canterbury (ECan) operations staff investigated Mount Harding Creek (a natural stream section within the Pudding Hill stockwater race network). eDNA samples collected at multiple sites within the stream identified the presence of native fish species (including Canterbury galaxias at the uppermost site), and water quality samples suggested the water quality within Mount Harding Creek was moderate to good, with the upper sites generally appearing to have better water quality (less faecal material and lower concentrations of nutrients) than the lower sites.

Methodology

For this assessment, races within the Pudding Hill stockwater network were grouped into general classes (upper, middle and lower), based on their relative position within the race network extent (relative to the source of the network from the Pudding Hill stream). Sample sites were split across these classes and targeted a mix of main races (carrying a greater flow/volume of water) and local races (carrying a smaller volume).

15 sample sites were assessed via a range of field assessments to characterise the freshwater system. These assessments included:

- Rapid Habitat Assessments (RHA)
- The collection of eDNA including riverine taxon-independent community index (TICI) data
- The collection of analytical water quality samples (testing for Total Suspended Solids (TSS), Total Phosphorus (TP), Dissolved Reactive Phosphorus (DRP), Total Nitrogen (TN), *Escherichia coli (E.Coli)* and various other nitrogen species)
- The field measurement of other standard water quality parameters (pH, temperature, Dissolved Oxygen (DO), Oxidation Reduction Potential (ORP) and turbidity).

Summary of Results

Whilst acknowledging the limitations of using single data points to make detailed conclusions about the nature (and ecological value) of the entire race network, the data gathered during the field assessments indicates that there are areas across the stockwater network with high to moderate ecological value.

Contextual water quality data suggests a higher quality of water in the upper network races compared to the middle and lower network races. The middle and lower network races appear relatively similar in terms of water quality, with both areas generally appearing to carry higher loads of nutrients and faecal matter than the upper network area.

The water quality data is supported by the eDNA (TICI) results that show the upper network area as having the highest values, either in the 'excellent' range or marginally below (in the 'good' range) and the middle and lower network areas having slightly lower values (all in the 'good' range).

In terms of the presence and relative abundance of native fish, the eDNA (multi-species) results highlight differences between the three network areas. Canterbury Galaxias were only detected in the upper network sites (all four) and at a single site within the middle network area, and, as a native species with a conservation status of At Risk: Declining, their presence increases the potential ecological value of a given race / portion of the network. Longfin Eel were detected in a single lower network site, and similarly, as a native species with a conservation status of At Risk: Declining, their presence also likely increases the potential ecological value of races in the area.

Rapid Habitat Assessment results show upper network sites generally appearing to score higher overall habitat values (in the 'good' to 'fair' range) with sites in the middle and lower network scoring in the 'fair' range. This indicates that there are likely slightly higher-quality habitats (in the upper network) with features such as a higher availability and diversity of fish cover, a lower percentage of fine sediment covering the streambed and greater hydraulic heterogeneity (within the reaches assessed) compared to the middle and lower network areas, that still have good quality habitats, just with fewer of the features outlined above.

Using the EIANZ Ecological Impact Assessment (EcIA) Guidelines for assigning ecological value, the different race types have been assigned as having the following potential ecological values:

- Upper network races: **High**
- Middle network races: **Moderate**
- Lower network races: **Moderate**

Implications and Further Work

Despite the race network being comprised primarily of man-made watercourses, this assessment has highlighted that there are moderate to high ecological values present within the network and that the system supports a range of fish populations including threatened native species such as Canterbury galaxias and Longfin eel. Although the most recent survey work did not confirm the presence of Canterbury Mudfish, it is also possible that these are present in certain parts of the race network, based on previous survey work done by Opus.

Based on the results of this initial assessment of potential ecological value, and the previously issued Preliminary Planning Assessment, a full Ecological Impact Assessment (EcIA) is likely required to understand the likely impacts on the ecological values (identified) as a result of the proposed closure of the stockwater race network. It is also likely that a regime of fish salvage and relocation will be required during works related to the closure of the races, in addition to any other consent requirements that may be determined.

Given the extent of habitat impacted, it is recommended that a fish salvage and relocation plan is developed to support any closure plan, working in a phased manner with ADC's preferred contractor team during implementation. Because of the scale of the change, engagement with the Department of Conservation and the Ministry for Primary Industries (who part-regulate the 'take' of fish species) is also recommended, as there are additional obligations on the transfer of fish species from this type of catchment to a receiving waterbody.

1 Introduction

1.1 Background

Beca Limited (Beca) were commissioned by Ashburton District Council (ADC) to prepare a Summary of Findings for the set of field assessments carried out as part of the wider assessment of ecological value within the Pudding Hill stock water race network.

Beca understands that ADC are undertaking an assessment of the feasibility of closing the Pudding Hill stock water race network and that the information collected as part of this assessment will be used to inform the stock water closure plan with respect to ecological management.

1.2 Purpose and Scope

The purpose of this report is to provide a brief summary of findings from the field assessments, to describe the key ecological and water quality characteristics.

Information presented here may then be used to inform an Ecological Impact Assessment (EcIA) once any consenting requirements and the proposed strategy for closure of the stock water race network are confirmed.

The scope of the tasks for this report (and the field assessments) includes:

- Undertake site visits to gather ecological and water quality data at 15 sites across the stockwater race network including:
  - Collection of water quality samples
  - Collection of environmental DNA (eDNA) samples
  - Field measurements of water quality parameters
  - Undertaking of (freshwater) Rapid Habitat Assessments (RHA)
- Provide a brief summary of findings that outlines key ecological findings including:
  - Observations from the RHA
  - Water Quality Data
  - eDNA Data

2 Site Location and Existing Information Review

2.1 Site Location

The Pudding Hill stockwater race network is fed by a water take from the Pudding Hill stream at the base of the Canterbury Foothills adjacent to Hart Road, approximately 10 km south of the Mt Hutt ski area. The intake supports a race network that has a total length of approximately 220 km, consisting of both main and local races that flow between the Ashburton/Hakatere River North Branch (to the south) and the Rakaia River (to the north).

The Pudding Hill race system initially flows eastward towards the Rakaia River where Washpen Creek (flowing from the northwest to the southeast) reaches a confluence with the race system and augments the flow. For a brief distance of approximately 6 km (between the confluence with Washpen Creek and the gate at Draytons Gate) this section of the race network is classified as a 'natural' stream and the stream is known as Mount Harding Creek.

Generally, races in the Pudding Hill network then flow in a southeasterly direction towards SH1 (with a few branches flowing east for a time), with the last local race appearing to terminate near the small settlement of Overdale (south of the Rakaia township and adjacent to the west of SH1).

Figure 1 outlines the sample sites selected for the field assessments, the extent of the race network under assessment and the sections of the race network that are classified as a natural stream, main race or local race.

2.2 Ecological Context

The Pudding Hill race network is located in the Canterbury Plains area and sits across two ecological districts: the High Plains Ecological District (for the majority of races west and north of Methven) and the Low Plains Ecological District (for the races east and south of Methven)[1].

Prior to anthropogenic modification, both these areas would have had extensive sections of lowland, short tussock grassland with pockets of floodplain forest (native podocarp/hardwood). Significant land use changes have occurred post European settlement and the plains have been farmed intensively for sheep, cattle and crops. Planting of small exotic forests and the development of small rural centres (such as Methven and Rakaia) have also changed the land use characteristics of the area.

The water intake structure (to feed the Pudding Hill network) was first installed in 1876 and since then has been managed by ADC. The race network is hydrologically connected to the source stream (Pudding Hill Stream) at the take site, to Washpen Creek (mentioned above) and to the Methven Auxiliary race main, that flows from the Ashburton/Hakatere River North Branch and joins the Pudding Hill race system at Drayton Gate. There are no fish screen mechanisms installed at any of these connection points to natural streams. The Pudding Hill network stockwater races appear to discharge to ground and terminate before reaching SH1.

[1] McEwen, W. M. (1987). Ecological Regions and Districts of New Zealand. Department of Conservation.

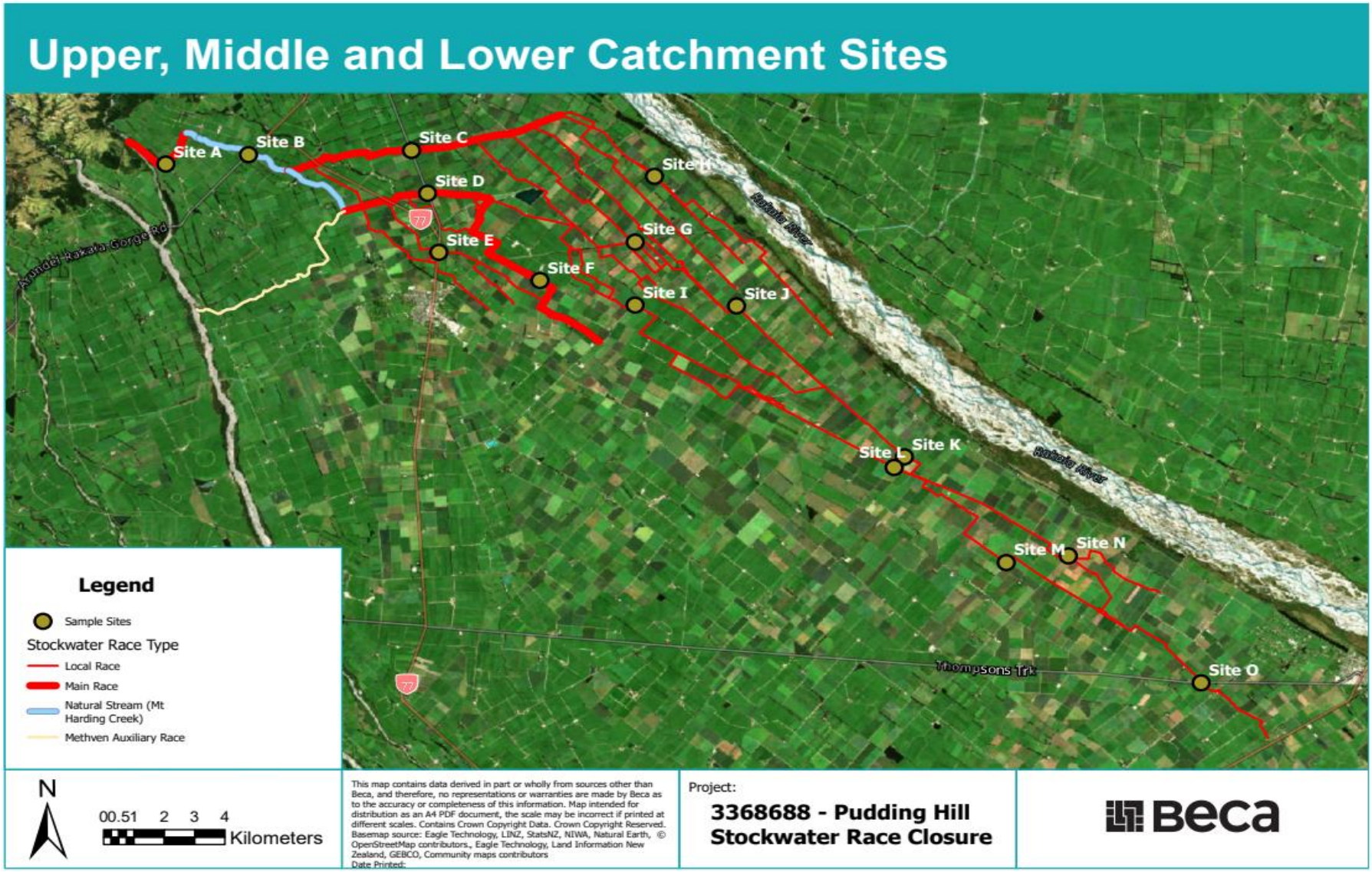

Figure 1. Site map of the Pudding Hill stockwater race network including the sample sites assessed in this investigation, the extent of the race network under assessment, the sections of the race network that are classified as a natural stream, main race or local race and the connection to the Methven Auxiliary race. Note: The Methven Auxiliary race is not within the scope of this assessment as it is not proposed to be impacted by the potential closure of the Pudding Hill network.

2.3 Background Information Review

2.3.1 Opus - Ecological Assessment of ADC Race Network (2014)

Opus (now WSP) conducted a high-level Ecological Assessment[2] of the entire ADC stockwater race network in 2014. The investigation consisted of a series of field assessments (including rapid survey/habitat assessments and conventional aquatic assessments such as fish surveys and the collection of aquatic macroinvertebrate samples) to determine the potential ecological value at 20 sample sites (Figure 2) across ADC's race network.

The sites were spread across the Canterbury Plains between the Rangitata River and the Rakaia River (south to north), west of the Methven township and approximately 6 km east of SH1 (west to east). The sites generally were situated in the middle-lower portions of the wider stockwater race network (as defined for the current assessment framework in this investigation later in Section 3.1).

The assessment considered attributes such as suitable Canterbury Mudfish/Kōwaro habitat (*Neochanna burrowsius*; Threatened – Nationally Critical), the abundance and community composition of macroinvertebrates (macroinvertebrate community index), the presence of native fish species, and other ecological health parameters such as the water clarity, presence of algae/macrophytes and riparian vegetation. The above attributes were evaluated for each site and an overall potential ecological value was assigned to each site.

The investigation concluded that:

- Only one of the sites (located approximately 1 km north of the Ashburton/Hakatere River North Branch and 15 km west of the Ashburton township) was deemed to hold a high potential ecological value (as Opus determined there was a high presence of suitable Canterbury Mudfish habitat available at the site).
- Four sites (between the Ashburton/Hakatere River South Branch and the Rangitata River) were deemed to hold a medium-high potential ecological value (due to the presence of Longfin Eel (*Anguilla dieffenbachia;* At Risk: Declining) and the moderate presence of suitable Canterbury Mudfish habitat available at the sites – as determined by Opus).
- All remaining 15 sites were deemed to hold a low potential ecological value due to a lack of suitable mudfish habitat and lack of presence of native fish species (captured or observed during the fish survey).

2.3.2 Environment Canterbury (ECan) – Review of Mount Harding/Washpen Creek (2022)

Environment Canterbury operations staff (ECan) conducted an investigation and review of Mount Harding Creek (also known as Washpen Creek above its confluence with the Pudding Hill stockwater network) in 2022. eDNA and water quality samples were collected and analysed across five sites (Figure 3) including parameters such as turbidity, ammoniacal nitrogen, nitrate-nitrite nitrogen, dissolved reactive phosphorus (DRP) and *Escherichia coli* (*E.coli*).

The water quality results suggested that the two uppermost sites (above or adjacent to Methven) had lower turbidity and lower concentrations of nutrients than sites lower in the race network (east of Methven towards the Ashburton/Hakatere River North Branch). Concentrations of *E.coli*, however, appeared highest in the uppermost site and then were relatively consistent across the other four sites.

eDNA samples detected native Galaxiid species (specifically Canterbury Galaxiids) at the uppermost site only. All other sites were dominated by Brown Trout and Bullies (predominantly Upland Bully). The lowermost site showed the most diversity, detecting Upland Bully, Brown Trout, Long-fin and Short-fin Eels, Chinook

[2] Opus International Consultants Ltd. Ecological Assessment & Management Plan: Ashburton Water Race Network. February 2014.

Salmon (*Oncorhynchus tshawytscha;* Introduced) and Torrentfish/panoko (*Cheimarrichthys fosteri;* At Risk – Declining).

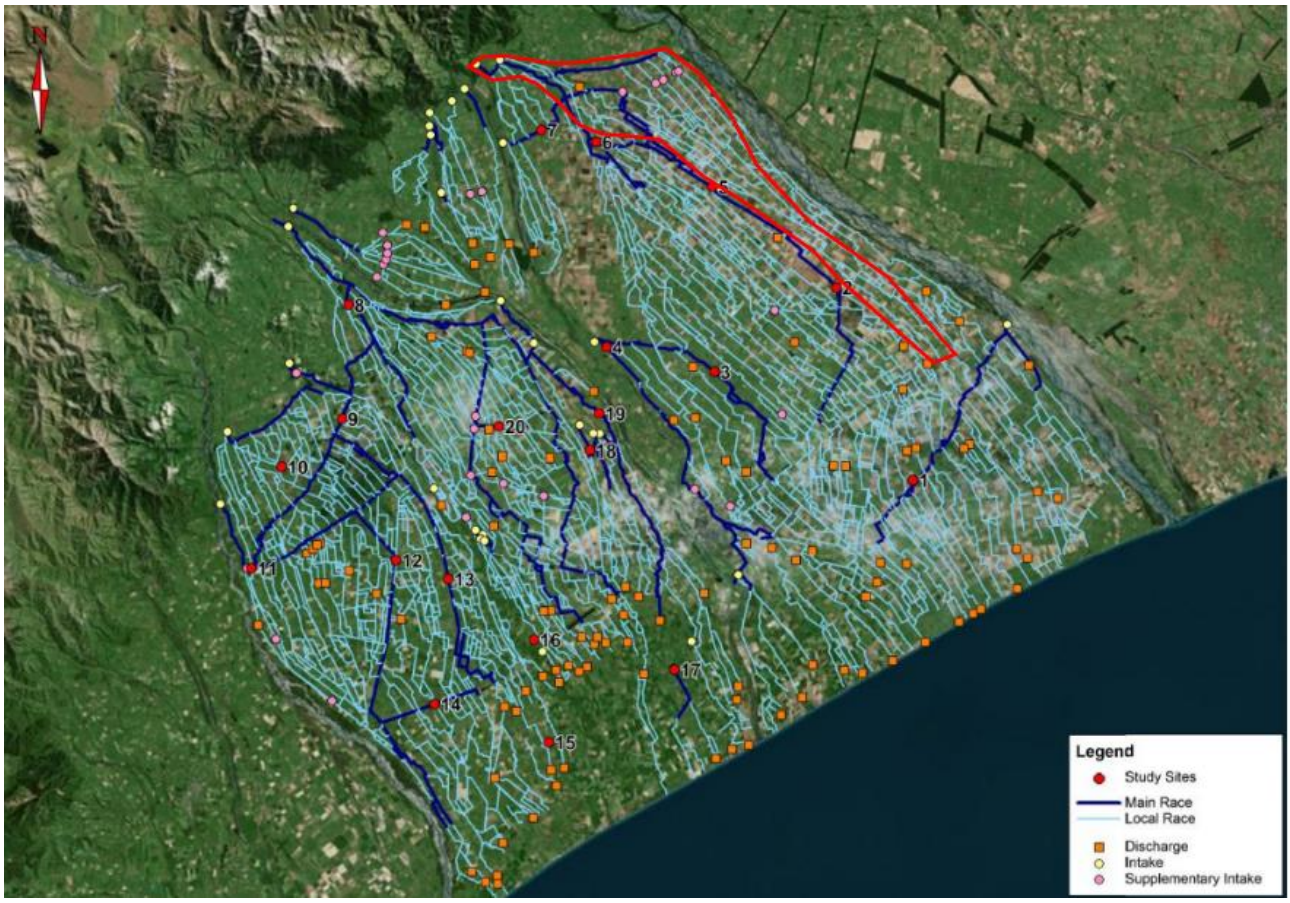

Figure 2. Map outlining sample sites assessed in the existing ecological assessment of the wider ADC stockwater network (Opus, 2014) and overlaid (in red) the indicative area of the Pudding Hill stockwater network.

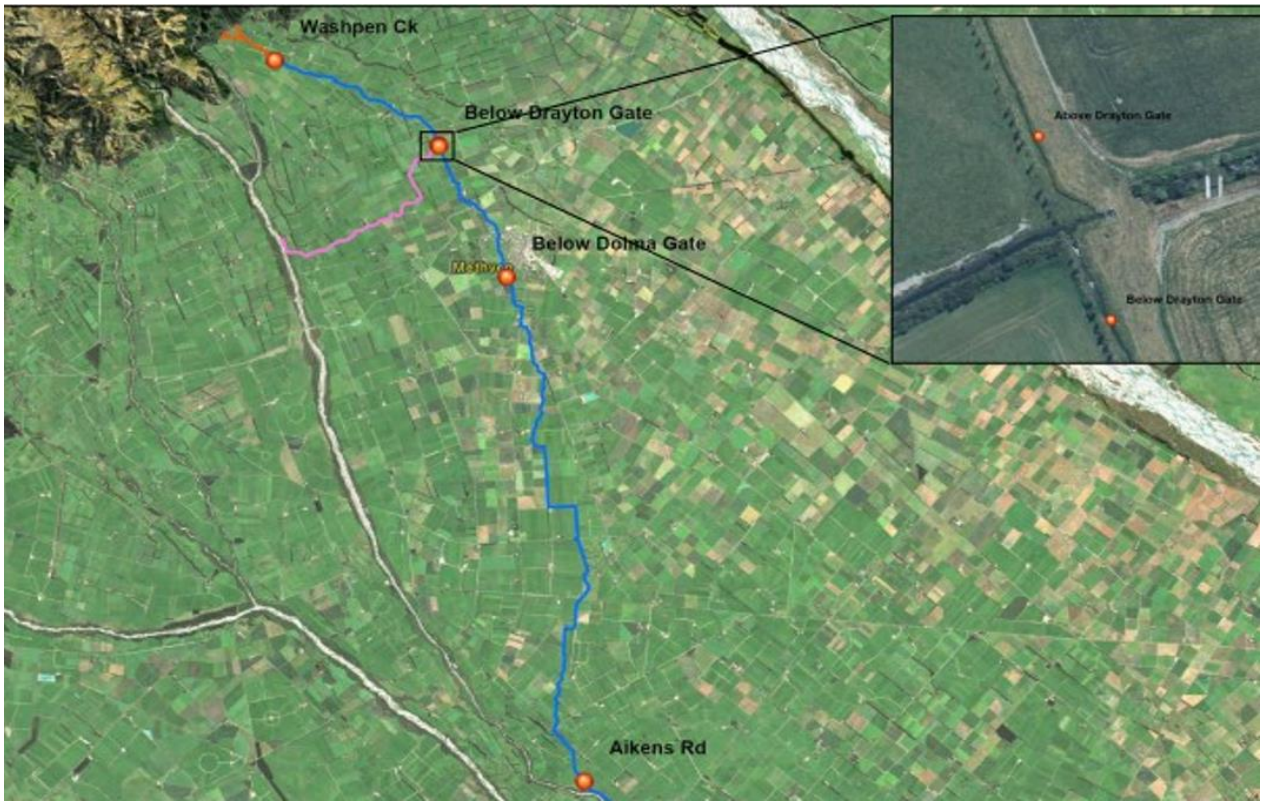

Figure 3. Map outlining sample locations assessed in the investigation into Mount Harding (Washpen) Creek (ECan, 2022).

3 Methodology

3.1 Delineation of Network/Classification of Sample Sites

The Pudding Hill stockwater race network has a total a length of approximately 220 km. As such, it is not practical or feasible to assess every individual race in the system.

In this assessment, races were grouped into general classes, based on their relative position within the Pudding Hill stockwater race extent (relative to the source of the network from the Pudding Hill stream). Sample sites were split across these classes, and also targeted a mix of main races (carrying a greater flow/volume of water) and local races (carrying a smaller volume). The 15 sites are outlined below:

- **Four upper network sites** (Sites A, B, C and D) are located northwest of Methven (including the sample site within Mount Harding Creek – Site B).
  - Includes four main races.
- **Six middle network sites** (Sites E, F, G, H, I and J) are located adjacent to, east and southeast of Methven (towards the Rakaia River and the Rakaia township).
  - Includes one main race and five local races.
- **Five lower network sites** (Sites K, L, M, N, O and P) are located towards the Rakaia township and SH1
  - Includes five local races.

3.2 Field Assessments

Site visits were undertaken on the 14th and 15th of October 2024 to collect ecological information and data from a series of water races within the Pudding Hill race network. The weather at the time of the site visit on the 14th was clear with no rain and on the 15th was overcast with scattered light rain showers.

There had been approximately 114.2 mm of rainfall in the previous two weeks[3] for the wider Methven area preceding the sampling. Stream flow data from the last 30 days for the Pudding Hill Stream at the ADC take[4], indicates several elevations in river flows coinciding with heavier rainfall events, with the last being on 15 October 2024 at approximately 10:00 am. This peak flow is approximately double (2.2 m^3/s) the regular base flow (1.1 m^3/s).

All upper race network sites (closest to the Pudding Hill Stream take) were sampled before this peak on the 14th of October and for samples collected on the 15th of October, the last samples were collected from the lower network sites by 15:00. The samples are therefore deemed to not have been impacted by the preceding rainfall events and are representative of normal flow conditions.

3.2.1 Water Quality Sampling

3.2.1.1 Analytical Samples

Water quality samples were collected from each of the 15 sites using a mighty gripper tool. Each sample was collected into laboratory-supplied sample containers and a clean pair of nitrile gloves were worn. Each sample was given a unique sample identification number and the location the sample was collected from was recorded.

Following collection, all samples were placed directly into a chilled chilly bin and were transported under standard chain of custody procedures to the laboratory for analysis, to ensure that samples were analysed

[3] Met Service. Retrieved on 22/10/2024 from https://www.metservice.com/weather-stationlocation/93756/methven.

[4] Environment Canterbury Regional Council. (2023). River Flow Data at Pudding Hill Stream at Upstream ADC Take. Retrieved 22/10/2024 from https://www.ecan.govt.nz/data/riverflow/sitedetails/68836

within the appropriate holding times for each analyte. Hill Laboratories performed all analyses and are International Accreditation New Zealand (IANZ) accredited. All test methods were also IANZ accredited.

The samples were then analysed for a range of standard analytes that can be used to characterise freshwater systems, including:

- Total Suspended Solids (TSS)
- Total Phosphorus (TP)
- Dissolved Reactive Phosphorus (DRP)
- Total Nitrogen (TN)
- *Escherichia coli (E.Coli)*
- Various nitrogen species including Nitrate-nitrogen (NO3-N), nitrite-nitrogen (NO2-N) and ammoniacal-nitrogen (NH4-N)

One duplicate sample was collected and analysed for the parameters above for quality assurance and quality control (QA/QC) purposes. The relative percentage difference (RPD) was calculated for the duplicate results to determine the percent variation between the duplicate and the parent sample.

3.2.1.2 Field Measurements

A YSI Pro DSS multi-meter probe (supplied by Van Walt Ltd) was used at each of the 15 sample sites to capture in-situ field measurements of temperature, dissolved oxygen (DO), specific conductivity (SPC), oxidation reduction potential (ORP) and turbidity. The multi-meter probe was suspended mid-stream for a minimum period of five minutes (to allow for the parameters to stabilise) and the values were then recorded on a logging sheet.

3.2.2 Rapid Habitat Assessment (RHA)

During the site visits on 14 and 15 October 2024, a Rapid Habitat Assessment (RHA) was undertaken on reaches of the stock water race systems at each of the 15 sites. The RHA provides an overall habitat quality score (Table 1) for a given reach or section of a stream which indicates the general stream habitat condition based on a variety of physical aspects related to the structure of the stream[5].

Table 1. Rapid Habitat Assessment (RHA) interpretation

RHA Habitat Condition Class	RHA Score
Excellent	76-100
Good	50-75
Fair	25-49
Poor	0-24

3.2.3 eDNA Sampling

One eDNA sample was collected at each of the 15 sites. Mini eDNA kits with 5 µm CA filters were used in accordance with the methodology recommended by Wilderlab Ltd[6]. Multi-species analyses by DNA metabarcoding were undertaken on eDNA samples by Wilderlab Ltd to produce a list of all DNA sequences detected within a broad taxonomic group (e.g., fish, insects, birds, mammals) and the number of times each appears in the sample.

[5] Cawthron Institute. Rapid Habitat Assessment Protocol. Accessed on 28/08/2024.

[6] Wilderlab. Directions for Sampling. https://www.wilderlab.co.nz/directions Accessed on 1/10/24.

These DNA sequences are then compared against a reference database to assign species names and characterise the community as a whole.

3.2.3.1 Riverine taxon-independent community index (TICI)

Based on the eDNA data, Wilderlab Ltd can also provide a riverine taxon-independent community index (TICI) value for each sample. This index effectively assigns values to different freshwater species (fish, invertebrates, bacteria) based on their perceived tolerance to the overall ecological health of the waterway.

More tolerant species (that can survive in poorer quality systems) are assigned lower values and more sensitive species (that require higher quality systems to support their functioning) are assigned higher values, culminating in an overall TICI value for each sample (or system) that can be used to infer the relative quality of the system (as outlined in Table 2). There is currently limited understanding on the potential impacts of dilution effects on TICI methods as a result of higher-than-average flow regimes (flushing flows) within a stream system. Typically, Macroinvertebrate Community Index (MCI) sampling would not have been undertaken in these conditions.

Table 2. TICI Interpretation

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

3.2.4 Water Quality Assessment Criteria

As the water races in this assessment are largely non-natural stream systems (except for Site B, which is within Mount Harding Creek and is classed as a natural stream), it is important to note that the application of typical water quality criteria and the use of it for interpretation should be used for context, not management or policy-decision making purposes. These criteria values have been used to provide a high-level context on the general water quality in these systems, to further inform the likely ecological value of the race network and inform the race closure plan.

3.2.4.1 Criteria Values Applied

The following water quality criteria have been applied in this assessment:

- The Australian and New Zealand Environment Guidelines for Fresh and Marine Water Quality (ANZG, 2018) 80th percentile default guideline values (DGVs) for physical and chemical stressors.
  - Cool, wet hill (fed) (CW-H) values applied for all ten upper and middle network sites.
  - Cool, dry, low-elevation (CD-L) values applied for all five lower network sites.
- Region-wide Water Quality Limit values from Schedule 8 of the Canterbury Land and Water Regional Plan (LWRP, 2022).
  - 1 day (summer*) minimum value (for Hill-fed lower systems) applied for dissolved oxygen.
  - Annual maximum value (for Hill-fed lower systems) applied for ammoniacal nitrogen.
- Freshwater Outcomes for Canterbury Rivers values from Table 1a of the Canterbury Land and Water Regional Plan (LWRP, 2022).
  - 95th percentile value for *E.coli* human health attributes.

*Note: Samples for this investigation were not collected during the summer period (defined as 1 November to 30 April in Schedule 8 of the LWRP).

3.2.5 Ecological Value - Assessment Methodology

An assessment of ecological effects was undertaken in accordance with Ecological Impact Assessment (EcIA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems (Roper-Lindsay et al., 2018).

The EIANZ guidelines set out a methodology to assign ecological value to species and ecosystems based on four assessment criteria which are consistent with significance assessment criteria set out in the Proposed National Policy Statement for Indigenous Biodiversity (2019) Appendix A: Criteria for identifying significant indigenous vegetation and significant habitat of indigenous fauna.

In summary:

- Attributes are considered when considering ecological value or importance. They relate to matters such as representativeness, the rarity and distinctiveness, diversity and patterns, and the broader ecological context.
- Determining Factors for valuing terrestrial species; terrestrial species span a continuum of very high to negligible, depending on aspects such as whether species are native or exotic, have threat status, and their abundance and commonality at the site impacted.
- Ecological Values are scored based on an expert judgement, qualitative and quantitative data collected.

4 Field Assessment Results

Field assessments were undertaken at 15 sample sites across the Pudding Hill stock race network, following the methodologies outlined in Section 3.

Sites were situated on both main and local races (as defined by ADC) and covered upper network (four sites), mid network (six sites), and lower network (five sites) areas of the stock race network.

The results from the field assessments for the different network areas are summarised in Sections 4.1 – 4.3.

The contextual water quality results (covering both field measurements and analytical results) are presented first, followed by the aquatic ecology results (rapid habitat assessment and eDNA) followed by a final general summary of the network area, synthesising all of the results.

Full analytical results (for both the water quality and eDNA datasets) are provided in **Appendix A** and **B** respectively. Site photos taken during the RHA at each site are also provided in **Appendix C**.

Table 3. All 15 field assessment sites.

Site Name	Network Class	Race Type	X Coordinate	Y Coordinate
Site A	Upper Network	Main	1482098.07	5173387.91
Site B	Upper Network	Main *(Mount Harding Creek)*	1484821.49	5173729.81
Site C	Upper Network	Main	1490195.29	5173883.48
Site D	Upper Network	Main	1490722.69	5172316.57
Site E	Mid Network	Local	1491096.57	5170158.64
Site F	Mid Network	Main	1494429.86	5169130.37
Site G	Mid Network	Local	1497547.18	5170532.604
Site H	Mid Network	Local	1506442.05	5162683.15
Site I	Mid Network	Local	1498202.37	5172938.75
Site J	Mid Network	Local	1497565.42	5168231.77
Site K	Lower Network	Local	1500909.14	5168200.10
Site L	Lower Network	Local	1509798.01	5158814.83
Site M	Lower Network	Local	1511846.29	5159059.89
Site N	Lower Network	Local	1516222.33	5154420.10
Site O	Lower Network	Local	1506102.79	5162292.65

4.2 Upper Network (Sites A, B, C and D)

4.2.1 Water Quality Results

Table 4. Summary of field measured parameters for upper network sites (including comparison against guideline criteria values).

Field Measured Parameters	Site A	Site B	Site C	Site D	ANZG P/C Stressor CW/H	LWRP WQ Limits
Temperature (^{0}C)	5.6	7.8	8.3	8.9	-	-
pH (pH units)	7.61	7.31	7.59	7.65	7.35 - 7.8	-
Dissolved Oxygen (mg/L)	12.21	11.6	11.96	11.42	-	<5
Specific Conductivity (µS/cm)	78.2	79.8	82.9	87.7	95	-
Oxidation Reduction Potential (mV)	53	50.8	60.7	60.6	-	-
Turbidity (NTU)	1.19	0.63	**3.63**	**2.81**	2.4	-

Note: Results above ANZG P/C stressor values are **bold underlined** and results above the LWRP water quality limits are in red text. Values for pH reported as an optimum range rather than an upper limit.

The field measurements for the four upper network sites suggest the water quality is in a relatively good state. The only recorded exceedances of the guideline criteria values were for turbidity and these values were only marginally above the criteria.

Table 5. Summary of analytical results for upper network sites (including comparison against guideline criteria values).

Analytical Parameters	Site A	Site B	Site C	Site D	ANZG P/C Stressor CW/H	LWRP WQ Limits
Total Suspended Solids (g/m^3)	< 3	< 3	**6.0**	**5.0**	2.6	-
Escherichia coli (MPN/100mL)	2	37	517	142	-	1000
Total Kjeldahl Nitrogen (TKN) (g/m^3)	< 0.10	< 0.10	0.11	< 0.10	-	-
Total Phosphorus (g/m^3)	<0.002	0.003	0.013	0.007	0.016	-
Total Nitrogen (g/m^3)	0.11	**0.31**	**0.68**	**0.96**	0.238	-
Total Ammoniacal-N (g/m^3)	<0.010	<0.010	**0.017**	<0.010	0.006	0.05
Nitrate-N (g/m^3)	0.053	**0.27**	**0.57**	**0.89**	0.087	-
Nitrate-N + Nitrite-N (g/m^3)	0.053	0.27	0.57	0.9	-	-
Dissolved Reactive Phosphorus (g/m^3)	<0.004	<0.004	0.006	<0.004	0.08	-

Note: Results above ANZG P/C stressor values are **bold underlined** and results above the LWRP water quality limits are in red text. Results below the laboratory limit of detection (L.O.D) are in grey text. Nitrite-N was recorded below the (L.O.D) at all four sites and is not reported in this table.

The analytical results for the four upper network sites also suggest that the water quality across the sites is relatively healthy. Marginal exceedances were reported for at least one parameter at all of the sites (except for Site A) with Site C having the most exceedances in total (four) for concentrations of TSS, total nitrogen, ammoniacal nitrogen and nitrate-N.

4.2.2 Aquatic Ecology Results

4.2.2.1 eDNA

Table 6. Summary of key eDNA results for upper network sites. Threatened species in **bold text.**

Site Name	Native Fish Detected	Scientific Name(s)	Common Name(s)	Conservation Status	TICI Value (and rating)
Site A	Yes	*Gobiomorphus breviceps*	Upland Bully	Not Threatened	116.87 (Excellent)
Site B	Yes				113.27 (Excellent)
Site C	Yes				105.98 (Good)
Site D	Yes	***Galaxias vulgaris***	**Canterbury galaxias**	**At Risk: Declining**	108.34 (Good)

The eDNA results highlight the presence of both Canterbury Galaxias (At Risk: Declining) and Upland Bully (Not Threatened) throughout the upper network area of the Pudding Hill stockwater network as they were detected in all four of the sites. The TICI values also appear relatively high across the four sites with the two uppermost sites recording slightly higher values pushing them into the “excellent” condition class.

4.2.2.2 Rapid Habitat Assessment (RHA)

Table 7. RHA scores for upper network sites.

Site Name	Overall RHA score	RHA Habitat Condition Class
Site A	55	Good
Site B	60	Good
Site C	40	Fair
Site D	41	Fair

The RHA results suggest the race systems in the upper network area are generally of a good to fair habitat condition.

This is primarily based on the percentage of the streambed(s) that appeared clear of deposited sediment (particularly Sites A and B), the moderate-high amount and diversity of available fish cover, the moderate hydraulic heterogeneity (number of different hydraulic components such as riffles, pools, fast runs, slow runs) and the degree of shading (provided by riparian vegetation) across the reaches assessed.

4.2.3 Assessed Ecological Value

Overall, the snapshot of ecological and contextual water quality data, and the limited existing data indicates that the ecological value of the upper network sites, is likely to be **moderate-high** following the EIANZ Ecological Impact Assessment (EcIA) Guidelines for assigning ecological value.

This is based on the likely presence of an At Risk: Declining species of native fish (Canterbury Galaxias), the TICI ratings of excellent and good (likely driven by a high percentage/detection rate of EPT macroinvertebrate taxa), the generally high habitat condition of the races as determined by the RHA (that are likely to support populations of native fish) and the contextual water quality data that suggests the races in the upper network are in a generally healthy condition (as they do not contain excessive levels of nutrients or faecal bacteria) and largely meet the water quality limits (and characteristics expected) of natural stream systems in the Canterbury region.

Table 8. Scoring and justification for assigned ecological value to the upper network Sites.

Matter	Rating	Justification
Representativeness	High	Natural meander and in-stream habitat. Limited erosion and deposited sediment on the streambed. Moderate-high water quality value – TICI values of Excellent and Good. Modified agricultural catchment. Moderate exotic riparian vegetation provides limited shading. Limited macrophyte growth.
Rarity/Distinctiveness	High	Permanent stream that likely provides habitat for At Risk fish species year round (Canterbury galaxias detected at all four sites). Fish passage not impeded.
Diversity and Pattern	Moderate	Moderate in-stream habitat heterogeneity – comprising typical, healthy riffle-run structure.
Ecological context	Moderate	Important role in providing connectivity between headwaters and wider race system. Provider of native fish spawning and juvenile fish habitats. Some land use pressures from agriculture.
		Overall value: **High**

4.3 Middle Network (Sites E, F, G, H, I and J)

4.3.1 Water Quality Results

Table 9. Summary of field measured parameters for the middle network sites (including comparison against guideline criteria values).

Field Measured Parameters	Site E	Site F	Site G	Site H	Site I	Site J	ANZG P/C Stressor CW/H	LWRP WQ Limits
Temperature (^{0}C)	15.7	15.1	11.7	8.8	8.4	8.7	-	-
pH (pH units)	**8.6**	**9.51**	**7.89**	7.51	7.48	7.64	7.35 - 7.8	-
Dissolved Oxygen (mg/L)	11.43	12.3	10.8	11.03	11.65	11.85	-	<5
Specific Conductivity (µS/cm)	82.1	78.8	84	81.6	86.3	82.8	95	-
Oxidation Reduction Potential (mV)	57.5	56.8	62.2	64	60.4	65.6	-	-
Turbidity (NTU)	**22.45**	**3.54**	NA*	**18.24**	**10.38**	**10.65**	2.4	-

Note: Results above ANZG P/C stressor values are **bold underlined** and results above the LWRP water quality limits are in red text.
Values for pH reported as an optimum range rather than an upper limit.

*NA = the turbidity value at site G did not stabilise (following five minutes of monitoring time) so a reading was not reported.

The field measurements for the six middle network sites suggest the water quality is in a moderately healthy state. The only recorded exceedances of the guideline criteria values were for turbidity (at all sites where measurements were possible) and for pH (at sites E, F and G) where the pH appeared slightly more alkaline than the ANZG criteria range, with the value at Site F being the most alkaline with a pH of 9.51. Water temperatures at sites E and F also appeared higher than throughout the rest of the network. This could be attributed to a lack of riparian shading upgradient of these two sites.

Table 10. Summary of analytical results for middle network sites (including comparison against guideline criteria values).

Analytical Parameters	Site E	Site F	Site G	Site H	Site I	Site J	ANZG P/C Stressor CW/H	LWRP WQ Limits
Total Suspended Solids (g/m^3)	**41.0**	**7.0**	**5.0**	**37.0**	**14.0**	**14.0**	2.6	-
Escherichia coli (MPN/100mL)	27	291	248	>2,420	1986	649	-	1000
Total Kjeldahl Nitrogen (TKN) (g/m^3)	0.35	0.26	0.13	0.19	0.36	0.18	-	-
Total Phosphorus (g/m^3)	**0.069**	**0.02**	**0.019**	**0.1**	**0.019**	**0.032**	0.016	-
Total Nitrogen (g/m^3)	**1.04**	**0.78**	**0.85**	**0.4**	**1.1**	**0.6**	0.238	-
Total Ammoniacal-N (g/m^3)	**0.022**	<0.010	**0.02**	**0.019**	**0.021**	<0.010	0.006	0.05
Nitrite-N (g/m^3)	0.006	0.007	0.005	0.004	0.004	0.005	-	-
Nitrate-N (g/m^3)	**0.68**	**0.51**	**0.71**	**0.22**	**0.68**	**0.39**	0.087	-
Nitrate-N + Nitrite-N (g/m^3)	0.69	0.51	0.71	0.22	0.68	0.39	-	-
Dissolved Reactive Phosphorus (g/m^3)	**0.013**	<0.004	0.008	0.008	<0.004	<0.004	0.008	-

Note: Results above ANZG P/C stressor values are **bold underlined** and results above the LWRP water quality limits are in red text.
Results below the laboratory limit of detection (L.O.D) are in grey text.

The analytical results for the six middle network sites suggest that the water quality across the sites is of moderate to fair health, exhibiting that there is some likely impact of localised runoff (nutrients and faecal indicator bacteria) from adjacent and upstream farming practices that may be entering the drain network.

Exceedances of the selected water quality guidance values were reported across multiple parameters at all of the sites, with Site E having the most exceedances in total (six) for concentrations of TSS, total nitrogen, total phosphorus, dissolved reactive phosphorus, ammoniacal nitrogen and nitrate-N. Sites H and I also had exceedances for a range of nutrients and for *E.coli* with the value for Site H being at least more than two times greater than the criteria value (<2420 MPN/100mL vs the criteria value of 1000 MPN/100mL).

4.3.2 Aquatic Ecology Results

4.3.2.1 Rapid Habitat Assessment (RHA)

Table 11. RHA Scores for Middle Network Sites

Site Name	Overall RHA score	RHA Habitat Condition Class
Site E	35	Fair
Site F	41	Fair
Site G	37	Fair
Site H	28	Fair
Site I	51	Good
Site J	30	Fair

The RHA results suggest the race systems in the middle network area are generally of a fair habitat condition with Site I having a slightly better overall habitat condition (being in good condition).

This is primarily based on the moderate amount of deposited sediment on the streambed(s), the moderate amount and diversity of available fish cover, the moderate-low hydraulic heterogeneity and the moderate-low percentage of suitable substrate or habitat for macroinvertebrate communities.

4.3.2.2 eDNA

Table 12. Summary of key eDNA results for middle network sites. Threatened species in **bold text.**

Site Name	Native Fish Detected	Scientific Name	Common Name	Conservation Status	TICI Value (and rating)
Site E	Yes	*Gobiomorphus breviceps*	Upland Bully	Not Threatened	104.71 (Good)
Site F	Yes				103.1 (Good)
Site G	Yes				104.21 (Good)
Site H	Yes				103.56 (Good)
Site I	Yes				104.17 (Good)
		Galaxias vulgaris	**Canterbury galaxias**	**At Risk: Declining**	
Site J	Yes	*Gobiomorphus breviceps*	Upland Bully	Not Threatened	104.71 (Good)

The eDNA results highlight the presence of Upland Bully (Not Threatened) throughout the middle network area. Of more interest is the detection of Canterbury Galaxias (At Risk: Declining) in a single site (Site I –east of the Methven township). The TICI values also appear relatively high across the six sites with all values in the “good” condition class.

4.3.3 Assessed Ecological Value

Overall, the snapshot of ecological and contextual water quality data, and the limited existing data indicates that the ecological value of the middle network sites, is likely to be **moderate** following the EIANZ Ecological Impact Assessment Guidelines for assigning ecological value.

This is based on the likely presence of an At Risk: Declining species of native fish (Canterbury Galaxias) within at least one of the sections of the races assessed in this area of the race network, the TICI ratings of good (likely driven by a moderate-high percentage/detection rate of EPT macroinvertebrate taxa) and the generally fair habitat condition of the races as determined by the RHA (that are likely to support small populations of native fish and macroinvertebrate communities).

The contextual water quality data also suggests that races in the middle network are in a moderate condition (with respect to water quality) with some potentially elevated levels of nutrients and faecal bacteria observed (faecal matter in Sites H and I only) and in several cases, these values exceeded the region wide water quality limits for natural stream systems in the Canterbury region.

Table 13. Scoring and justification for assigned ecological value to the Middle Network Sites.

Matter	Rating	Justification
Representativeness	Low	Modified race type systems, with moderate in-stream habitat. Limited erosion and deposited sediment on the streambed. Moderate water quality value – TICI values of Good for all sites. Modified agricultural catchment. Low exotic riparian vegetation provides limited shading. Limited macrophyte growth.
Rarity/Distinctiveness	High	Permanent stream that likely provides habitat for At Risk fish species year round (Canterbury galaxias detected at one site). Fish passage not impeded.
Diversity and Pattern	Low	Modified race type systems. Moderate-low in-stream habitat heterogeneity – comprising typical, healthy slow run – fast run structure.
Ecological context	Moderate	Important role in providing connectivity between headwaters and wider race system. Provider of native fish spawning and juvenile fish habitats. Some land use pressures from agriculture.
		Overall value: **Moderate**

4.4 Lower Network (Sites K, L, M, N and O)

4.4.1 Water Quality Results

Table 14. Summary of field measured parameters for the lower netork sites (including comparison against guideline criteria values).

Field Measured Parameters	Site K	Site L	Site M	Site N	Site O	ANZG P/C Stressor CD/L	LWRP WQ Limits
Temperature (^{0}C)	9.5	10.5	10	10.6	10.9	-	-
pH (pH units)	**8.11**	**8.11**	7.88	7.42	7.58	7.23 - 7.8	-
Dissolved Oxygen (mg/L)	12.26	12.17	11.77	10.91	11.15	-	<5
Specific Conductivity (µS/cm)	83.8	87.6	82	83.6	80.9	116	-
Oxidation Reduction Potential (mV)	60	67.7	66.7	63.2	67.6	-	-
Turbidity (NTU)	**20.16**	**73.89**	**35.3**	**24.83**	**66.65**	1.3	-

Note: Results above ANZG P/C stressor values are **bold underlined** and results above the LWRP water quality limits are in red text. Values for pH reported as an optimum range rather than an upper limit.

The field measurements for the five lower network sites suggest the water quality is in a moderately good state. The only recorded exceedances of the guideline criteria values were for turbidity (at all sites) and for pH (at sites K and L only) where the pH appeared marginally more alkaline than the ANZG criteria range.

Table 15. Summary of analytical results for lower network sites (including comparison against guideline criteria values).

Analytical Parameters	Site K	Site L	Site M	Site N	Site O	ANZG P/C Stressor CD/L	LWRP WQ Limits
Total Suspended Solids (g/m^3)	**40.0**	**144.0**	**49.0**	**23.0**	**91.0**	2.1	-
Escherichia coli (MPN/100mL)	613	>2,420	1733	1300	1733	-	1000
Total Kjeldahl Nitrogen (TKN) (g/m^3)	0.32	0.39	0.29	0.52	0.76	-	-
Total Phosphorus (g/m^3)	**0.088**	**0.24**	**0.1**	**0.076**	**0.33**	0.014	-
Total Nitrogen (g/m^3)	0.7	0.7	0.5	0.7	**1.0**	0.91	-
Total Ammoniacal-N (g/m^3)	<0.010	**0.032**	<0.010	**0.031**	**0.019**	0.01	0.05
Nitrite-N (g/m^3)	0.005	0.009	0.006	0.005	0.009	-	-
Nitrate-N (g/m^3)	**0.33**	**0.33**	0.196	0.151	0.188	0.27	-
Nitrate-N + Nitrite-N (g/m^3)	0.34	0.34	0.2	0.156	0.197	-	-
Dissolved Reactive Phosphorus (g/m^3)	0.006	0.008	0.005	**0.01**	**0.01**	0.008	-

Note: Results above ANZG P/C stressor values are **bold underlined** and results above the LWRP water quality limits are in red text. Results below the laboratory limit of detection (L.O.D) are in grey text.

The analytical results for the five middle network sites suggest that the water quality across the sites is of moderate to fair condition. Impacts from adjacent / upstream localised runoff do not appear to have increased from the mid-network sites in terms of nutrients and faecal indicator bacteria.

Exceedances were reported across multiple parameters at all of the sites, with the majority of sites recording exceedances for concentrations of TSS, total phosphorus, ammoniacal nitrogen and nitrate-N. All sites barring Site K also exceeded the criteria for *E.coli,* with the value for Site L being at least more than two times greater than the criteria value (<2420 MPN/100mL vs the criteria value of 1000 MPN/100mL).

4.4.1.1 QA/QC

A duplicate sample was collected from Site K and analysed for the same parameters as the parent sample. The maximum relative percentage difference (RPD) value across all the parameters was 37% and the average was 12.3%. The higher value (by 37%) was reported for Total Kjeldahl Nitrogen and the difference between the duplicate sample was only 0.1 g/m^3. Overall, the results suggest an acceptable level of consistency in the sampling methods employed during the field assessments.

4.4.2 Aquatic Ecology Results

4.4.2.1 RHA Results

Table 16. RHA Scores for Lower Network Sites

Site Name	Overall RHA score	RHA Habitat Condition Class
Site K	27	Fair
Site L	29	Fair
Site M	32	Fair
Site N	30	Fair
Site O	36	Fair

The RHA results suggest the race systems in the middle network area are generally of a fair habitat condition.

This is primarily based on the moderate amount of deposited sediment on the streambed(s), the moderate amount and diversity of available fish cover, the moderate-low hydraulic heterogeneity and the moderate-low percentage of suitable substrate or habitat for macroinvertebrate communities.

4.4.2.2 eDNA Results

Table 17. Summary of key eDNA results for middle network sites. Threatened species in **bold text.**

Site Name	Native Fish Detected	Scientific Name	Common Name	Conservation Status	TICI Value (and rating)
Site K	Yes	*Gobiomorphus breviceps*	Upland Bully	Not Threatened	103.16 (Good)
Site L	Yes				103.65 (Good)
Site M	Yes				103 (Good)
Site N	Yes				101.77 (Good)
Site O	Yes				101.51 (Good)
		Anguilla dieffenbachii	**Longfin Eel**	**At Risk: Declining**	

The eDNA results highlight the presence of Upland Bully (Not Threatened) throughout the lower network area as they were detected in all five of the sites. Of more significance is the detection of Longfin Eel (At Risk: Declining) at a single site (Site O - the closest site to the Rakaia township). The TICI values also appear relatively high across the five sites with all values in the “good” condition class.

4.4.3 Assessed Ecological Value

Overall, the snapshot of ecological and contextual water quality data, and the limited existing data indicates that the ecological value of the lower network sites, is likely to be **moderate** following the EIANZ Ecological Impact Assessment Guidelines for assigning ecological value.

This is based on the likely presence of an At Risk: Declining species of native fish (Longfin Eel) within at least one of the sections of the races assessed in this area of the network, the TICI ratings of good (likely driven by a moderate-high percentage/detection rate of EPT macroinvertebrate taxa), and the generally fair habitat condition of the races as determined by the RHA (that are likely to support small populations of native fish and macroinvertebrate communities).

The contextual water quality data also suggests that races in the lower network are in a moderate to fair condition (with respect to water quality) with some potentially elevated levels of nutrients and faecal bacteria observed across the sites and in several cases, these values exceeded the region wide water quality limits for natural stream systems in the Canterbury region.

Table 18. Table 19. Scoring and justification for assigned ecological value to the Lower Network Sites

Matter	Rating	Justification
Representativeness	Low	Modified race type systems, with moderate in-stream habitat. Moderate erosion and some deposited sediment on the streambed. Moderate water quality value – TICI values of Good for all sites. Modified agricultural catchment. Low exotic riparian vegetation provides limited shading. Moderate macrophyte growth.
Rarity/Distinctiveness	High	Permanent stream that likely provides habitat for At Risk fish species year round (Longfin eel detected at one site). Fish passage not impeded.
Diversity and Pattern	Low	Modified race type systems. Moderate-low in-stream habitat heterogeneity – comprising typical, healthy slow run-fast run structure.
Ecological context	Moderate	Important role in providing connectivity between headwaters and wider race system. Provider of native fish spawning and juvenile fish habitats. Some land use pressures from agriculture.
		Overall value: **Moderate**

5 Initial Conclusions, Implications and Further Work

5.1 Overall Summary

This snapshot assessment of ecological value was targeted to describe potential differences and change within the broad sub-network groups across the Pudding Hill stockwater network. Whilst acknowledging the limitations of using single data points to make detailed conclusions about the nature (and ecological value) of the entire race network, using the data gathered during the field assessments, there is evidence to suggest that there may be areas with high ecological value and others with moderate ecological value across the Pudding Hill stockwater network.

Contextual water quality data appears to highlight a higher quality of water in the upper network races compared to the middle and lower network races; this better water quality in turn, likely provides a more favourable bio-physical environment for more sensitive and higher value species to reside and thrive. The middle and lower network races appear relatively similar in terms of water quality, with both network areas appearing to carry higher loads of nutrients and faecal matter than the upper network area.

The water quality data is supported by the eDNA (TICI) results (Figure 4) that show the upper network area as having the highest values, either in the 'excellent' range or marginally below (in the 'good' range) and the middle and lower network areas having slightly lower values (all in the 'good' range).

In terms of the presence and relative abundance of native fish, the eDNA (multi-species) results (Figure 5) highlight some differences between the three network areas. Canterbury Galaxias were only detected in the upper network sites (all four) and at a single site within the middle network area, and, as a native species with a conservation status of At Risk: Declining, their presence increases the potential ecological value of a given race. Longfin Eel were detected in a single lower network site, and similarly, as a native species with a conservation status of At Risk: Declining, their presence also likely increases the potential ecological value of races in the area.

The results of the Rapid Habitat Assessments (RHA) across the three sub-network areas further illustrate the differences outlined above, with sites in the upper network generally appearing to score higher overall habitat values (in the 'good' to 'fair' range) with sites in the middle and lower network scoring in the 'fair' range. This indicates that there are likely slightly higher-quality habitats (in the upper network) with features such as a higher availability and diversity of fish cover, a lower percentage of fine sediment covering the streambed and greater hydraulic heterogeneity (within the reaches assessed) compared to the middle and lower network areas, that still have good quality habitats, just with fewer of the features outlined above.

The limited extent of existing data for stockwater races in the Ashburton District (and for Mount Harding Creek/Washpen Creek) generally support the results of this assessment with similar water quality results observed and species of native fish detected. Existing (ECan) data for Mount Harding Creek suggests a higher quality of water in the upper network areas compared with the middle – lower network and a greater abundance of native fish species were also observed in the upper network. Conclusions from the Opus report also strengthen the argument that there are both high and moderate potential ecological values across the Pudding Hill stockwater race network.

Overall, based on the results in this assessment the different race types have been classified as having the following potential ecological values:

- Upper Network Races: **High**
- Middle Network Races: **Moderate**
- Lower Network Races: **Moderate**

5.2 Summary Figures (across the network areas)

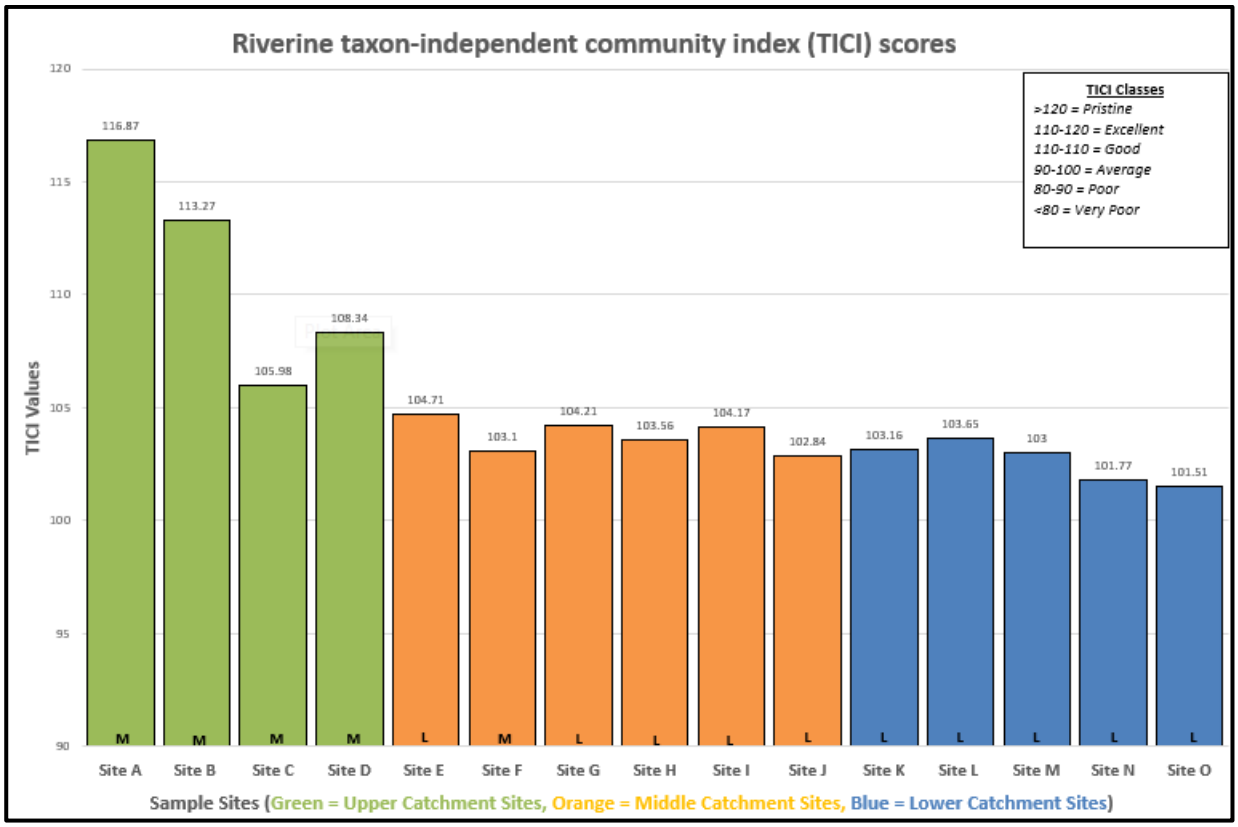

Figure 4. Summary of TICI values (and scores) across the Upper, Middle and Lower Network Sites. Letters M or L denote whether the site was in a main or local race.

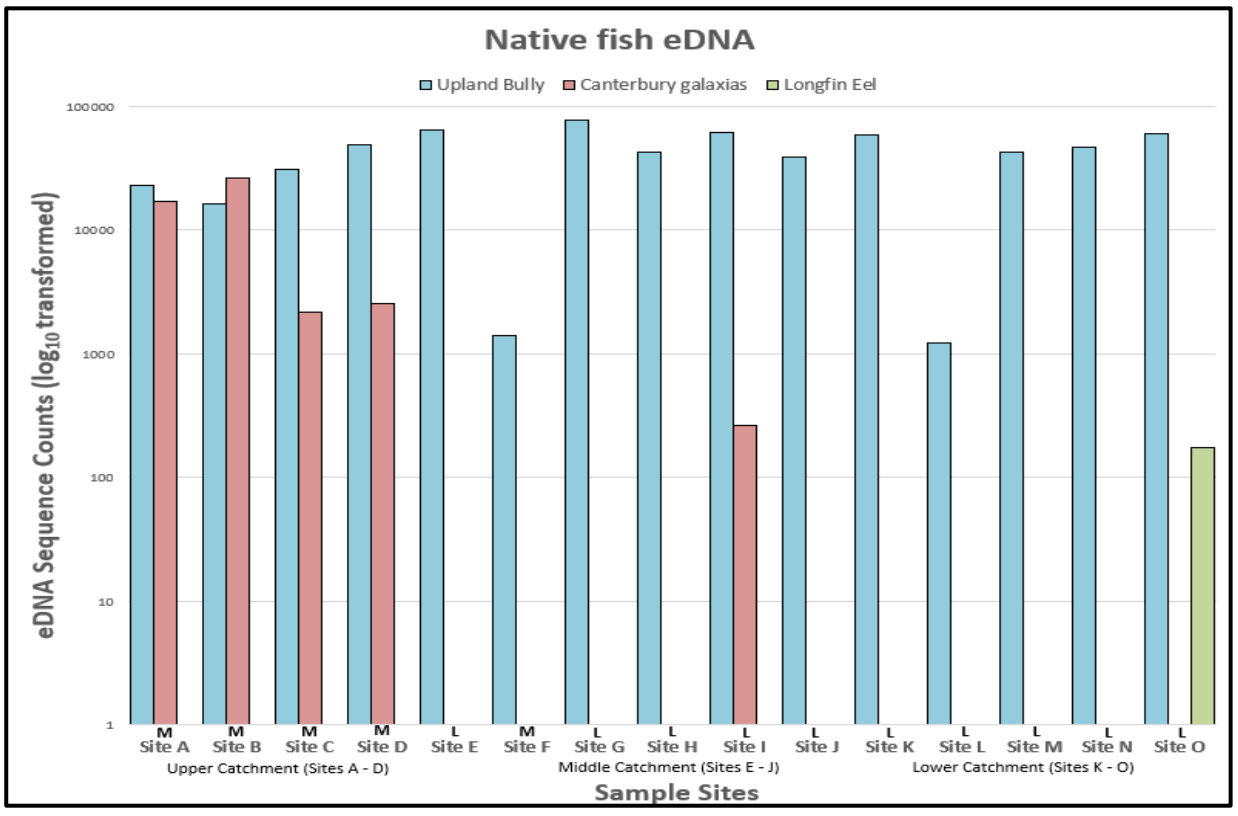

Figure 5. Summary of native fish eDNA detections across the Upper, Middle and Lower Network Sites. Letters M or L denote whether the site was in a main or local race.

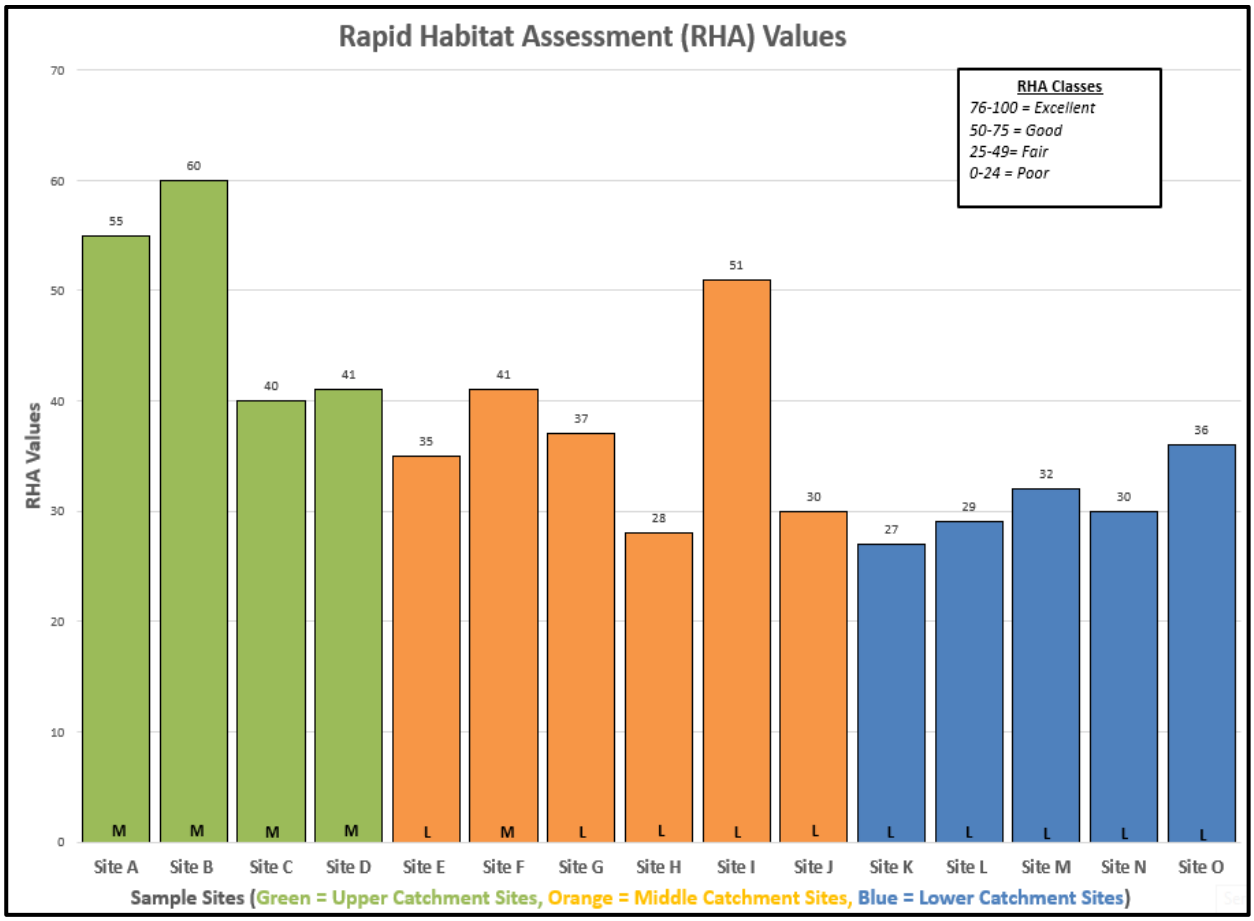

Figure 6. Rapid Habitat Assessment (RHA) values across the Upper, Middle and Lower Network Sites. Letters M or L denote whether the site was in a main or local race.

5.3 Key implications on management of closure

Although the race network is primarily comprised of man-made watercourses designed to convey water for agricultural purposes (outside of Mt Harding Creek), this assessment has shown that there are moderate to high ecological values present within the network – and that the race network subject to potential closure, supports a range of native fish species such as Canterbury galaxias, Longfin eel and Upland bully.

There may also be some Canterbury Mudfish present (based on assessments made by others (Opus) previously) despite them not being detected in any of the races assessed in this one-off survey, with some areas of the race network having possibly suitable habitat for these species.

A regime of fish salvage and relocation could be undertaken during the programme of works if the races are to be closed, in addition to any other consent requirements that may be determined.

Given the extent of habitat impacted, it is recommended that a fish salvage and relocation plan is developed to effect any closure plan, working in a phased manner with ADC's preferred contractor team during implementation. Because of the scale of the change, engagement with the Department of Conservation and the Ministry for Primary Industries (who part-regulate the 'take' of fish species) is also recommended, as there are additional obligations on the transfer of fish species from this type of Network to a receiving waterbody.

5.4 Further Work

5.4.1 Ecological Impact Assessment (EcIA)

Based on the results of this initial assessment of ecological value within the Pudding Hill stockwater network, and the conclusions from the Preliminary Planning Assessment[7] (Beca, 2024) that highlighted the requirement for the consideration of potential adverse effects (including ecological effects) as a result of the proposed closure of the stockwater race network, a full Ecological Impact Assessment (EcIA) is required to understand the likely impacts on the ecological values (identified in this assessment).

The proposed methodology or mechanism of closure for the race network (or the range of options currently being considered by ADC) will heavily inform this assessment.

[7] Beca. Preliminary Planning Assessment – Pudding Hill Intake. October 2024.

A

Appendix A – Results Analysis Table (Water Quality)

Results Analysis Table - Pudding Hill Stockwater Races

																Assessment Criteria		
Sample Location	Site A	Site B	Site C	Site D	Site E	Site F	Site G	Site H	Site I	Site J	Site K	Site L	Site M	Site N	Site O	ANZG Physical and Chemical Stressor CW/H DGVs [1]	ANZG Physical and Chemical Stressor CD/L DGVs [1]	LWRP Region Wide Water Quality Limit [2]
Sample Date	14.10.24							15.10.24										
Catchment Type	Upper				Middle						Lower							
Race Type	Artificial	Natural	Artificial		Artificial						Artificial							
Race Size	Main	Main	Main	Main	Local	Main	Local	Local	Local	Local	Local	Local	Local	Local	Local			
River Environment Classification (REC)	Cool-Wet Hill (CW/H)										Cool-Dry Low Elevation (CD/L)							
Lab Number	3693627.1	3693627.2	3693627.3	3693627.4	3693627.5	3693627.6	3693627.7	3694217.1	3694217.2	3694217.3	3694217.4	3694217.5	3694217.6	3694217.7	3694217.8			
Analytical Water Quality Parameters																		
Total Suspended Solids (g/m^3)	< 3	< 3	6.0	5.0	41.0	7.0	5.0	37.0	14.0	14.0	40.0	144.0	49.0	23.0	91.0	2.6	2.1	-
Escherichia coli (MPN/100mL)	2	37	517	142	27	291	248	> 2,420	1986	649	613	> 2,420	1733	1300	1733	-	-	1000
Total Kjeldahl Nitrogen (TKN) (g/m^3)	< 0.10	< 0.10	0.11	< 0.10	0.35	0.26	0.13	0.19	0.36	0.18	0.32	0.39	0.29	0.52	0.76	-	-	-
Total Phosphorus (g/m^3)	< 0.002	0.003	0.013	0.007	**0.069**	**0.02**	**0.019**	**0.1**	**0.019**	**0.032**	**0.088**	**0.24**	**0.1**	**0.076**	**0.33**	0.016	0.014	-
Total Nitrogen (g/m^3)	0.11	**0.31**	**0.68**	**0.96**	**1.04**	**0.78**	**0.85**	**0.4**	**1.1**	**0.6**	0.7	0.7	0.5	0.7	**0.96**	0.238	0.91	-
Total Ammoniacal-N (g/m^3)	< 0.010	< 0.010	**0.017**	< 0.010	**0.022**	< 0.010	**0.02**	**0.019**	**0.021**	< 0.010	< 0.010	**0.032**	< 0.010	**0.031**	**0.019**	0.006	0.01	0.05
Nitrite-N (g/m^3)	< 0.002	< 0.002	< 0.002	< 0.002	0.006	0.007	0.005	0.004	0.004	0.005	0.005	0.009	0.006	0.005	0.009	-	-	-
Nitrate-N (g/m^3)	0.053	**0.27**	**0.57**	**0.89**	**0.68**	**0.51**	**0.71**	**0.22**	**0.68**	**0.39**	**0.33**	**0.33**	0.196	0.151	0.188	0.087	0.27	-
Nitrate-N + Nitrite-N (g/m^3)	0.053	0.27	0.57	0.9	0.69	0.51	0.71	0.22	0.68	0.39	0.34	0.34	0.2	0.156	0.197	-	-	-
Dissolved Reactive Phosphorus (g/m^3)	< 0.004	< 0.004	0.006	< 0.004	**0.013**	< 0.004	0.008	0.008	< 0.004	< 0.004	0.006	0.008	0.005	**0.01**	**0.01**	0.008	0.008	-
Field Measured Parameters																		
Temperature (^{0}C)	5.6	7.8	8.3	8.9	15.7	15.1	11.7	8.8	8.4	8.7	9.5	10.5	10	10.6	10.9	-	-	-
pH (pH units)	7.61	7.31	7.59	7.65	**8.6**	**9.51**	**7.89**	7.51	7.48	7.64	**8.11**	**8.11**	7.88	7.42	7.58	7.35 - 7.8	7.23 - 7.8	-
Dissolved Oxygen (mg/L)	12.21	11.6	11.96	11.42	11.43	12.3	10.8	11.03	11.65	11.85	12.26	12.17	11.77	10.91	11.15	-	-	<5
Specific Conductivity (µS/cm)	78.2	79.8	82.9	87.7	82.1	78.8	84	81.6	86.3	82.8	83.8	87.6	82	83.6	80.9	95	116	-
Oxidation Reduction Potential (mV)	53	50.8	60.7	60.6	57.5	56.8	62.2	64	60.4	65.6	60	67.7	66.7	63.2	67.6	-	-	-
Turbidity (NTU)	1.19	0.63	**3.63**	**2.81**	**22.45**	**3.54**	NA*	**18.24**	**10.38**	**10.65**	**20.16**	**73.89**	**35.3**	**24.83**	**66.65**	2.4	1.3	-

Key:

Above ANZG Criteria (bold)

Above LWRP Criteria (red text)

Annotations:

1. The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018). 80th perecentile, River Enviornment Classification (REC) default guideline values (DGVs) for physical and chemical stressors. Values for Cool Wet, Hill (CW/H) systems applied for the upper and middle catchment sites. Cool Dry, Low Elevation (CD/L) systems applied for the lower catchment sites.

2. The Canterbury Land and Water Regional Plan (LWRP) region wide water quality limits applied (Schedule 8 - LWRP, 2022).

* Stable turbidity reading unable to be obtained for Site G.

BDL = Below laboratory limit of detection.

Results Analysis Table: Relative Percentage Difference

Sample Location	Site K	DUP_1	RPD
Sample Date	15.10.24	15.10.24	
Lab Number	3694217.4	3694217.9	
Analytical Water Quality Parameters			
Total Suspended Solids (g/m^3)	40.0	38.0	5.1
Escherichia coli (MPN/100mL)	613.0	461.0	28.3
Total Kjeldahl Nitrogen (TKN) (g/m^3)	0.3	0.2	37.0
Total Phosphorus (g/m^3)	0.1	0.1	18.6
Total Nitrogen (g/m^3)	0.7	0.6	18.2
Total Ammoniacal-N (g/m^3)	< 0.010	< 0.010	-
Nitrite-N (g/m^3)	0.0	0.0	0.0
Nitrate-N (g/m^3)	0.3	0.3	0.0
Nitrate-N + Nitrite-N (g/m^3)	0.3	0.3	3.0
Dissolved Reactive Phosphorus (g/m^3)	0.0	0.0	0.0

Average RPD	12.3

B

Appendix B – Full eDNA Dataset

Scientific Name	Tax ID	Common Name	Group	Site A	Site B	Site C	Site D	Site E	Site F	Site G	Site H	Site I	Site J	Site K	Site L	Site M	Site N	Site O
Gobiomorphus breviceps	300741	Upland bully	Fish	12623	4254	11153	26598	28591	536	37474	18146	25903	23921	23547	899	22014	24553	22212
Anas platyrhynchos	8839	Mallard duck; rakiraki	Birds	1843	603	13915	3725	1899	25508	586	5846	5167	8755	1055	15105	3939	665	5388
Nasturtium officinale	65948	Watercress; wātakirihi; kōwhitiwhiti	Plants	0	1719	618	1327	3429	3625	15157	16350	11407	1401	3499	671	6431	10741	3087
Lumbriculus variegatus	61662	Blackworm	Worms	4916	1340	10454	1812	837	2989	998	10685	1334	2067	2420	16699	8743	1944	2493
Closterium baillyanum	1416941	Charophyte green algae	Other	0	0	28240	5712	16536	0	86	0	0	4084	0	0	0	0	0
Lumbricus rubellus	35632	Red earthworm	Worms	210	4983	2613	138	31	19355	205	1761	3058	4467	801	2107	3187	4121	3138
Nais christinae	1138466	Sludgeworm	Worms	0	0	71	0	0	1069	0	186	1237	1528	156	30514	5456	232	2081
Tubifex tubifex	6386	Sludge worm	Worms	1779	2711	2062	541	1640	7302	135	296	4423	2199	1262	5458	1706	677	3853
Chaetogaster diaphanus	212246	Oligochaete worm	Worms	0	944	1815	187	335	4667	117	1940	833	4753	1480	6401	2998	2007	7323
Limnodrilus hoffmeisteri	76587	Redworm	Worms	768	198	201	0	3314	193	338	2406	1752	4596	1922	4749	1678	1861	8721
Chaetogaster diastrophus	74727	Oligochaete worm	Worms	68	495	103	134	0	28632	563	73	157	145	56	311	134	0	117
Glyceria declinata	52154	Low Manna Grass	Plants	13347	581	133	163	558	174	2286	1557	2535	2410	1138	933	1600	1958	1575
Bos taurus	9913	Cattle; kau	Mammals	0	976	1203	1601	95	711	155	2654	2004	134	0	10110	7331	0	3177
Galaxias vulgaris	66449	Canterbury galaxias	Fish	7709	16019	1366	2155	0	0	0	0	267	0	0	0	0	0	0
Nais elinguis	74736	Sludgeworm	Worms	423	2693	2499	1091	74	5780	132	715	726	5407	1383	30	433	821	55
Aulodrilus pluriseta	76585	Aquatic oligochaete worm	Worms	0	2025	1819	523	2372	338	239	313	3281	3503	1168	473	577	637	2169
Bothrioneurum vejdovskyanum	188204	Worm	Worms	0	0	101	0	0	604	328	353	725	1442	993	5280	3239	444	3163
Ovis aries	9940	Sheep; pirikahu; hipi	Mammals	0	0	0	481	0	0	82	5329	1218	762	398	453	4941	819	413
Chamaecyparis lawsoniana	58030	Port Orford cedar; Lawson cypress	Plants	0	0	267	4760	5582	289	446	673	0	209	0	0	0	0	1078
Elodea canadensis	100364	Pondweed; waterweed	Plants	0	0	390	58	1326	0	5084	1244	748	843	1546	0	1390	312	327
Sphaerium novaezelandiae	192880	NZ freshwater clam	Molluscs	201	0	1376	0	1600	465	1612	2137	672	1882	793	0	89	1417	287
Salmo trutta	8032	Brown trout; taraute; tarauta	Fish	0	2366	5402	2292	0	0	0	0	272	50	0	0	0	0	0
Holcus lanatus	29679	Yorkshire fog	Plants	130	789	228	478	596	1108	1913	33	3153	513	501	0	196	479	191
Ranunculus sceleratus	147635		Plants	0	0	8736	0	0	0	43	0	58	0	348	345	567	0	119
Acanthocyclops robustus	415614	Copepod	Crustaceans	0	0	0	261	0	6329	462	1391	332	620	0	38	0	588	0
Eiseniella tetraedra	1302610	Squaretail worm	Worms	144	1857	415	162	39	1475	28	597	868	634	396	876	266	115	351
Chamaedrilus aff. glandulosus B SM-2014	1502718	Worm	Worms	415	0	231	14	47	4225	37	454	162	429	74	667	364	9	202
Octolasion cyaneum	302033	Worm	Worms	323	436	678	132	35	1849	40	501	1155	973	113	277	179	38	177
Rhopalosiphum padi	40932	Bird cherry-oat aphid	Insects	0	39	450	49	0	3866	17	244	0	30	391	199	65	390	1064
Lepus europaeus	9983	Brown hare; hea	Mammals	127	0	365	0	0	5375	0	0	0	0	860	0	0	44	0
Stylodrilus heringianus	77571	Worm	Worms	168	0	100	61	37	1286	102	617	771	555	96	1321	630	105	389
Glyceria notata	388682		Plants	0	1118	691	1773	162	14	36	6	1624	663	85	0	0	16	0
Potamogeton crispus	55318	Curly-leaf pondweed	Plants	0	0	9	5149	0	48	0	0	622	45	0	0	0	0	0
Physella acuta	109671	Left handed sinistral snail	Molluscs	0	0	168	221	504	378	1338	181	244	675	336	455	103	488	204
Stentor roeselii	1703786	Ciliate	Ciliates	248	899	6	176	24	82	1241	21	1126	352	426	0	407	27	14
Carpodetus serratus	54173	Putaputaweta; putaputawētā	Plants	2278	865	479	192	192	390	124	0	228	0	0	0	0	0	0
Aporrectodea caliginosa	302032	Worm	Worms	86	710	44	25	29	1128	0	158	289	223	131	789	49	86	85
Salix alba	75704	White willow	Plants	44	1118	95	139	15	0	0	30	0	33	0	0	0	0	2167
Cricotopus sp. NZeP20	1667446	NZ mining midge	Insects	143	196	45	155	68	273	172	220	134	591	929	176	120	215	170
Sturnus vulgaris	9172	Common starling; tāringi	Birds	0	0	102	0	0	0	72	352	2784	148	0	0	0	0	0

Scientific Name	Tax ID	Common Name	Group	Site A	Site B	Site C	Site D	Site E	Site F	Site G	Site H	Site I	Site J	Site K	Site L	Site M	Site N	Site O
Audouinella hermannii	31360	Black algae	Red algae	1730	865	92	182	13	0	6	0	16	0	0	0	0	74	51
Nais communis/variabilis complex sp. A1	1138460	Sludgeworm	Worms	216	2180	60	64	57	0	0	0	83	0	63	178	0	34	0
Potamogeton cheesemanii	1405354		Plants	0	0	60	63	0	0	0	0	0	0	2567	14	127	11	27
Hudsonema alienum	699955	Cased caddisfly	Insects	75	158	43	296	234	15	135	112	379	221	848	8	66	126	58
Trichosurus vulpecula	9337	Common brushtail possum; paihamu; paihama	Mammals	213	0	288	156	0	46	31	1342	263	205	7	0	0	67	127
Nais communis	188228	Sludgeworm	Worms	1506	348	6	339	41	46	108	0	59	14	26	76	0	95	0
Cervus elaphus	9860	Red Deer; tia	Mammals	1595	0	0	0	0	828	0	0	192	0	0	0	0	0	0
Potamopyrgus antipodarum	145637	Mud Snail	Molluscs	34	64	190	244	164	0	216	184	68	182	208	75	106	252	65
Enchytraeus buchholzi complex sp. 2 MK-2019	2664990	Grindal worm	Worms	100	528	32	60	0	881	36	0	208	0	20	0	0	0	0
Poa trivialis	89684	Rough bluegrass	Plants	0	182	312	277	184	330	23	364	0	0	0	0	0	134	23
Dactylis glomerata	4509	Catgrass; cocksfoot	Plants	0	0	0	0	0	0	0	0	608	573	0	377	0	0	242
Passer domesticus	48849	House sparrow; tiu	Birds	0	0	92	562	281	0	46	0	416	169	0	0	0	0	0
Acyrthosiphon kondoi	34664		Insects	24	0	0	87	0	0	23	87	0	0	72	0	32	444	754
Trifolium repens	3899	Creeping white clover	Plants	0	41	0	0	54	54	27	401	110	80	202	236	179	77	50
Stenostomum sthenum	1611831		Flatworms	0	0	0	0	0	0	1467	14	0	0	0	0	0	0	0
Myosotis laxa	192342	Water forget-me-not	Plants	0	0	10	0	0	49	173	115	56	100	89	231	323	0	231
Rattus norvegicus	10116	Norway Rat; pouhawaiki; pou o hawaiki; kaingarua; maungarua	Mammals	0	0	0	284	0	0	0	52	533	0	361	0	135	0	0
Dimocarpus longan	128017	Longan	Plants	0	72	39	784	109	0	297	63	0	0	0	0	0	0	0
Acyrthosiphon pisum	7029	Pea aphid	Insects	0	105	0	165	0	469	47	124	79	21	0	0	59	242	43
Aristotelia serrata	140574	Wineberry; makomako	Plants	985	263	104	0	0	0	0	0	0	0	0	0	0	0	0
Aporrectodea trapezoides	408844	Southern worm	Worms	0	0	0	0	0	795	0	0	0	0	0	228	0	51	178
Juncus articulatus	223654	Jointleaf rush	Plants	0	0	37	16	156	0	47	21	126	48	101	158	110	246	27
Magnoliophyta environmental sample	202726		Plants	144	294	0	50	231	16	0	0	0	0	74	0	75	76	14
Myzus ornatus	44658	Ornate aphid; violet aphid	Insects	0	98	219	0	121	61	0	73	0	0	245	0	0	52	63
Sherardia arvensis	29803	Field madder	Plants	0	0	0	0	62	0	0	0	0	12	42	628	24	42	101
Cyclotella cryptica	29204	Brackish-water diatom	Diatoms	0	6	20	0	24	0	0	0	0	0	0	568	137	0	113
Triplectides obsoletus	697963	NZ caddisfly	Insects	0	0	608	115	129	0	11	0	0	0	0	0	0	0	0
Aoteapsyche colonica	177870	NZ caddisfly	Insects	424	121	53	208	0	15	0	0	23	0	6	0	0	0	0
Fringilla coelebs	37598	Common chaffinch; pahirini	Birds	692	0	140	0	0	0	0	0	0	0	0	0	0	0	0
Ceratophysella aff. denticulata L3	2449137	Mushroom springtail	Springtails	50	29	0	335	39	0	0	48	23	0	291	0	13	0	0
Hydropsyche catherinae	1875486	Netspinning caddisfly	Insects	0	0	0	72	0	0	0	0	0	0	595	0	49	73	7
embryophyte environmental sample	171925		Other	0	105	429	147	0	0	0	0	0	29	0	0	18	0	0
Carex secta	291486	Makura	Plants	0	0	158	0	0	0	0	0	343	0	0	0	0	0	131
Tadorna variegata	107024	Paradise Shelduck; pūtangitangi	Birds	0	0	77	0	0	0	0	0	0	368	0	0	0	0	169
Limnodrilus udekemianus	146604	Worm	Worms	313	0	0	0	0	0	19	0	0	160	29	0	0	0	79
Prunella modularis	181117	Dunnock	Birds	0	197	0	120	0	0	0	0	0	0	212	0	0	0	0
Tanytarsus sp. EJD-2015	1763607	Non-biting midge	Insects	36	0	0	15	52	0	169	0	55	70	15	0	96	0	0
Marchantia polymorpha	3197		Liverworts	22	0	0	0	0	0	41	37	0	170	0	229	0	0	0

Scientific Name	Tax ID	Common Name	Group	Site A	Site B	Site C	Site D	Site E	Site F	Site G	Site H	Site I	Site J	Site K	Site L	Site M	Site N	Site O
Anas chlorotis or gracilis	10000052	Brown or grey teal; pāteke	Birds	0	0	0	319	0	0	0	0	0	0	0	0	0	0	168
Turdus philomelos	127946	Song thrush	Birds	0	220	0	0	0	0	84	0	175	0	0	0	0	0	0
Galium aparine	29788		Plants	0	369	0	0	0	6	0	0	0	21	0	0	27	15	40
Sheathia transpacifica	2781386	Red alga	Red algae	0	0	10	388	0	0	6	0	6	8	0	0	0	11	0
Psilochorema bidens	1968986	NZ caddisfly	Insects	23	34	50	119	57	10	37	0	34	37	15	0	0	9	0
Fuchsia excorticata	253483	Tree fuchsia; New Zealand fuchsia; kōtukutuku	Plants	265	152	0	0	0	0	0	0	0	0	0	0	0	0	0
Stellaria media	13274	Chickweed	Plants	0	34	0	0	158	47	40	0	67	34	0	0	0	27	0
Encyonema sp. WJS-2015a	1752053	Diatom	Diatoms	50	69	7	38	0	41	21	11	45	63	30	0	0	5	17
Brevicoryne brassicae	69196	Cabbage aphid	Insects	0	0	0	0	0	0	18	0	0	0	0	0	0	368	0
Hirundo neoxena	317132	Welcome swallow; warou	Birds	0	0	106	260	0	0	0	0	0	0	0	0	0	0	0
Cernosvitoviella aggtelekiensis	913639	Worm	Worms	0	30	0	20	0	0	0	0	11	9	30	0	249	0	8
Zantedeschia aethiopica	69721	Calla lily; Arum lily	Plants	0	0	0	0	0	0	0	0	0	355	0	0	0	0	0
Didymosphenia geminata	1115533	Didymo	Diatoms	234	111	0	0	0	0	0	0	0	0	0	0	0	0	0
Cardamine hirsuta	50463	Hairy bittercress	Plants	99	0	0	75	0	0	51	12	0	14	0	0	79	0	0
Acer pseudoplatanus	4026	Sycamore maple	Plants	38	0	52	54	18	0	0	131	0	28	0	0	0	0	0
Carduelis carduelis	37600	Goldfinch	Birds	0	0	0	321	0	0	0	0	0	0	0	0	0	0	0
Porcellio scaber	64697	Woodlouse; Slater	Crustaceans	0	0	51	134	0	0	0	28	24	0	0	0	48	34	0
Hydra vulgaris	6087	Hydra	Cnidarians	0	0	17	0	0	0	122	0	11	26	19	10	76	0	23
Candona candida	1112786	Ostracod	Crustaceans	0	6	19	0	29	0	42	15	0	25	0	0	0	0	145
uncultured Pythium	205931		Oomycetes	10	21	30	39	13	40	30	15	47	25	0	0	0	0	0
Ulex europaeus	3902	Gorse; Furze	Plants	0	0	0	0	0	0	0	0	0	130	0	0	0	94	44
Eisenia fetida	6396	Tiger worm	Worms	0	247	0	0	0	0	0	0	0	0	0	0	0	0	0
Bimastos rubidus	2866284	Worm	Worms	0	0	0	0	0	0	0	0	0	0	0	0	237	0	0
Sheathia confusa	373124	Freshwater red alga	Red algae	0	52	98	58	0	0	0	0	0	0	0	0	0	6	11
Lipaphis pseudobrassicae	511022		Insects	0	171	0	0	0	0	0	0	0	0	0	0	0	54	0
Cochliopodium kieliense	1512276	Amoeba	Amoebae	0	0	23	0	32	10	24	24	23	16	14	17	0	34	7
Veronica arvensis	46032	Field speedwell; corn speedwell	Plants	0	0	0	60	0	0	136	0	25	0	0	0	0	0	0
Trichoptera sp. 12KH6A	1878438		Insects	40	59	0	116	0	6	0	0	0	0	0	0	0	0	0
Sisymbrium officinale	203582		Plants	0	0	24	22	8	0	54	0	0	106	0	0	0	0	0
Hypogastrura purpurescens	999745	Springtail	Springtails	72	54	0	22	0	0	0	0	0	0	48	0	0	18	0
Henlea ventriculosa	913666	Worm	Worms	104	0	0	0	0	0	0	0	0	0	0	70	0	0	37
Conium maculatum	13447	Fool's-parsley	Plants	0	205	0	0	0	0	0	0	0	0	0	0	0	0	0
Populus deltoides	3696		Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	84	120
Limnodrilus claparedianus	1969536	Worm	Worms	0	0	0	0	0	0	0	0	0	0	146	0	0	40	0
Acer platanoides	4025	Norway maple	Plants	0	0	0	0	0	0	0	180	0	0	0	0	0	0	0
Helicopsyche albescens	426016	Spiral caddisfly	Insects	0	0	0	172	0	0	5	0	0	0	0	0	0	0	0
Mus musculus	10090	House mouse	Mammals	0	0	0	0	0	0	0	0	129	0	0	0	0	47	0
Anguilla dieffenbachii	61127	Longfin eel; tuna; kūwharuwharu; reherehe; kirirua	Fish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	176
Myzus ascalonicus	51993	Shallot aphid	Insects	0	19	12	0	0	57	5	24	0	0	30	0	20	0	5
Coloburiscus humeralis	241031	NZ spinygilled mayfly	Insects	6	0	61	90	0	0	14	0	0	0	0	0	0	0	0
Olinga feredayi	177813	Hornycased caddisfly	Insects	27	68	21	55	0	0	0	0	0	0	0	0	0	0	0
Polygonum aviculare	137693	Common knotgrass	Plants	0	0	0	0	0	0	17	0	0	11	0	59	15	0	65

Scientific Name	Tax ID	Common Name	Group	Site A	Site B	Site C	Site D	Site E	Site F	Site G	Site H	Site I	Site J	Site K	Site L	Site M	Site N	Site O
Globulidrilus riparius	1963000	Worm	Worms	0	0	0	0	0	0	0	12	0	0	0	100	45	0	0
Griselinia littoralis	86852	New Zealand broadleaf; pāpāuma; kapuka	Plants	62	69	0	0	0	0	5	0	0	0	0	0	0	18	0
Lepidochaetus zelinkai	1194624		Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	148
Henlea cf. andreae PDW-2010	913692	Worm	Worms	0	0	0	0	0	0	0	0	0	0	0	146	0	0	0
Prostoma eilhardi	41366	Freshwater ribbon worm	Ribbon worms	0	0	0	0	0	0	0	16	0	0	70	0	0	14	45
Rattus rattus	10117	Black Rat; hinamoki; inamoki	Mammals	0	0	0	0	0	0	0	0	0	0	0	0	0	142	0
Erodium moschatum	337392	Musky stork's-bill	Plants	0	0	0	0	0	0	0	0	23	0	41	27	35	14	0
Scorzoneroides autumnalis	212686	Autumn hawkbit; Fall dandelion	Plants	0	138	0	0	0	0	0	0	0	0	0	0	0	0	0
Rorippa palustris	50498	Bog yellowcress; marsh yellow-cress	Plants	0	0	0	0	0	0	32	14	0	0	0	42	30	17	0
Nitzschia acidoclinata	1302829	Diatom	Diatoms	0	0	0	7	0	17	7	10	0	10	25	48	0	10	0
Viola lutea	214047	Mountain pansy	Plants	0	0	0	0	0	0	0	15	0	0	0	0	116	0	0
Paracyclops fimbriatus	1606834	Copepod	Crustaceans	9	0	0	9	0	6	17	5	0	10	0	53	0	11	10
Pyrrosia hastata	872852		Plants	0	0	0	9	12	0	0	0	44	41	7	16	0	0	0
Liquidambar styraciflua	4400	American sweetgum	Plants	0	0	98	31	0	0	0	0	0	0	0	0	0	0	0
Coriaria arborea	48248	Tutu; tutu	Plants	129	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chamaedrilus glandulosus	1628863	Worm	Worms	28	0	0	5	16	7	0	19	0	5	16	13	18	0	0
Archichauliodes diversus	1763602	NZ dobsonfly	Insects	0	120	0	0	0	0	0	0	0	0	0	0	0	0	0
Anacharis zealandica	44355		Insects	0	0	120	0	0	0	0	0	0	0	0	0	0	0	0
Prostoma graecense	324887	Freshwater nemertean	Ribbon worms	0	0	0	0	0	6	22	23	14	0	40	0	0	14	0
Trebouxia aggregata	160068	Green algae	Green algae	0	20	0	9	0	0	0	0	10	63	14	0	0	0	0
Festuca myuros	89686	Annual fescue; Rat's-tail fescue	Plants	0	0	0	0	0	0	0	0	0	12	25	25	54	0	0
Isotomurus palustris	36144	Marsh springtail	Springtails	10	27	0	12	0	0	0	0	0	0	0	21	45	0	0
Artioposthia sp. MAP-2020	2725007		Flatworms	37	36	0	10	0	9	0	7	0	0	0	0	0	0	6
Rotaria rotatoria	231624	Rotifer	Rotifers	0	42	0	0	13	0	0	16	8	0	0	0	0	5	15
Pennantia corymbosa	159371	Kaikomako; kaikomako	Plants	99	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deroceras reticulatum	145610	Grey field slug; Grey garden slug	Molluscs	0	0	0	8	0	24	0	12	0	5	0	0	7	36	6
Entomobrya multifasciata	247613	Slender springtail	Springtails	0	65	0	0	0	0	7	0	0	0	24	0	0	0	0
Erinaceus europaeus	9365	European hedgehog; hetiheti; tuatete	Mammals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	93
Chaetogaster sp. CEJ	3032104		Worms	0	0	5	42	16	5	10	0	14	0	0	0	0	0	0
Phleum pratense	15957	Timothy	Plants	0	13	18	27	0	0	0	33	0	0	0	0	0	0	0
Aporrectodea limicola	647717	Worm	Worms	0	0	0	0	0	0	0	0	0	0	0	0	0	37	53
Costachorema callistum	697970	Caddisfly	Insects	75	13	0	0	0	0	0	0	0	0	0	0	0	0	0
Haplinis sp. CG162	1956649	South Pacific dwarf spider	Spiders	76	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aporrectodea tuberculata or caliginosa	10000116	Earthworm	Worms	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0
Pycnocentria evecta	633187	NZ caddisfly	Insects	60	6	0	0	0	0	9	0	0	0	0	0	0	0	0
Wiseana cervinata	107013	Porina moth	Insects	0	0	0	0	8	0	0	13	9	5	10	15	0	14	0
Philodina flaviceps	408863	Rotifer	Rotifers	0	0	0	0	20	0	26	13	0	0	0	0	15	0	0

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Paranephrops zealandicus	315725	Southern koura; kōura	Crustaceans	0	0	0	73	0	0	0	0	0	0	0	0	0	0	0
Borago officinalis	13363		Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	72	0
Zelandobius furcillatus	1777204	Stonefly	Insects	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nothocladus ater	69142	Red algae	Red algae	0	22	0	12	0	0	0	0	0	0	0	0	0	36	0
Deleatidium magnum	1968927	NZ mayfly	Insects	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fridericia perrieri	913657	Worm	Worms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	68
Hydropsyche tipua	1875518	Netspinning caddisfly	Insects	36	31	0	0	0	0	0	0	0	0	0	0	0	0	0
Mayamaea permitis	1302819	Diatom	Diatoms	0	0	0	0	0	13	0	0	0	0	12	0	10	26	0
Lupinus micranthus	53230		Plants	0	0	0	0	0	59	0	0	0	0	0	0	0	0	0
Hydrobiosis clavigera	1875463	Caddisfly	Insects	0	46	0	12	0	0	0	0	0	0	0	0	0	0	0
Mayetiola destructor	39758	Hessian fly	Insects	0	0	0	0	0	26	8	0	12	0	0	0	10	0	0
Beta vulgaris	161934	Sugar beet; beetroot; chard; mangelwurzel	Plants	0	0	0	55	0	0	0	0	0	0	0	0	0	0	0
Nais communis/variabilis complex sp. A3	1138462	Sludgeworm	Worms	18	0	0	7	8	0	19	0	0	0	0	0	0	0	0
Corynoneura scutellata	611450	Non-biting midge	Insects	0	0	0	0	7	15	0	0	0	0	9	0	0	20	0
Columba livia	8932	Pigeon	Birds	0	0	0	0	0	0	51	0	0	0	0	0	0	0	0
Stanleya tomentosa	536420		Plants	0	0	0	0	0	0	51	0	0	0	0	0	0	0	0
Festuca rothmaleri	200268		Plants	0	0	0	0	0	0	0	0	48	0	0	0	0	0	0
Ophyiulus pilosus	118470	Millipede	Other	9	10	0	0	0	5	0	8	6	9	0	0	0	0	0
Wiseana umbraculata	107019	Bog porina	Insects	7	11	0	29	0	0	0	0	0	0	0	0	0	0	0
Cirsium vulgare	92907		Plants	0	0	47	0	0	0	0	0	0	0	0	0	0	0	0
Frustulia vulgaris	431358	Diatom	Diatoms	0	0	0	0	0	0	0	9	6	7	0	7	16	0	0
Neanura muscorum	106920	Springtail	Springtails	0	17	0	0	0	0	0	0	0	0	26	0	0	0	0
Agrostis stolonifera	63632	Creeping bent grass	Plants	0	0	0	0	0	0	43	0	0	0	0	0	0	0	0
Alisma lanceolatum	365730	Lanceleaf water plantain; Narrow-leaved water plantain	Plants	0	0	0	0	0	0	0	0	0	0	5	0	18	0	19
Hedera helix	4052	English ivy	Plants	0	0	31	0	0	0	0	11	0	0	0	0	0	0	0
Salix purpurea	77065	Purple osier; Purple willow	Plants	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0
Neozephlebia scita	551888	Mayfly	Insects	0	0	13	28	0	0	0	0	0	0	0	0	0	0	0
Sellaphora cf. minima	433381	Diatom	Diatoms	0	0	0	0	0	41	0	0	0	0	0	0	0	0	0
Paraphysomonas sp.	1955561	Golden-brown alga	Heterokont	0	0	0	0	0	0	0	0	0	33	0	0	0	0	7
Aporrectodea longa	302031	Worm	Worms	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
Aploneura lentisci	136345	Root aphid	Insects	0	0	0	0	0	8	0	0	0	0	0	0	13	19	0
Cognettia chalupskyi	1628351	Worm	Worms	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0
Anthoxanthum odoratum	29661	Sweet vernal grass	Plants	0	37	0	0	0	0	0	0	0	0	0	0	0	0	0
Triplectides cephalotes	144281	Caddisfly	Insects	0	0	0	0	15	0	0	0	7	0	0	0	0	14	0
Haematopus unicolor	458153	Variable oystercatcher	Birds	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0
Oeconesus maori	177761	NZ caddisfly	Insects	0	0	0	29	0	0	0	0	6	0	0	0	0	0	0
Euphorbia helioscopia	154990		Plants	0	0	0	34	0	0	0	0	0	0	0	0	0	0	0
Cristaperla fimbria	714318	Stonefly	Insects	21	13	0	0	0	0	0	0	0	0	0	0	0	0	0
Chrysophyceae sp.	1955566		Heterokont	0	0	16	0	0	0	0	0	5	0	11	0	0	0	0
Citrithrix smalli	2770853		Ciliates	0	0	0	0	20	0	0	0	0	0	0	0	0	0	12
Austrosimulium australense	10000005	Sandfly	Insects	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0
Prunus pseudocerasus	151439	Chinese sour cherry	Plants	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0

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Diplocephalus cristatus	932989	Sheet weavers	Spiders	13	0	0	0	0	0	19	0	0	0	0	0	0	0	0
Matricaria matricarioides	56017		Plants	0	0	21	0	0	0	0	0	0	0	0	0	10	0	0
Tetraspora sp. UTEX-LB 234	106201	Green alga	Green algae	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0
Myzus persicae	13164	Green peach aphid	Insects	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0
Cerastium glomeratum	3580		Plants	0	0	9	0	0	0	0	20	0	0	0	0	0	0	0
Psilochorema macroharpax	2567402	NZ caddisfly	Insects	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zealandia pustulata	253765		Plants	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arabidopsis thaliana	3702	Thale cress	Plants	0	0	0	0	0	0	29	0	0	0	0	0	0	0	0
Pisum sativum	3888	Garden pea	Plants	0	0	0	0	0	0	15	0	0	13	0	0	0	0	0
Protaphorura armata	187684	Springtail	Springtails	0	15	0	13	0	0	0	0	0	0	0	0	0	0	0
Lunularia cruciata	56931		Liverworts	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0
Achillea millefolium	13329	Yarrow	Plants	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epiphyas postvittana	65032	Light brown apple moth	Insects	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Costachorema xanthopterum	697976	Caddisfly	Insects	21	6	0	0	0	0	0	0	0	0	0	0	0	0	0
Stellaria neglecta	1137911		Plants	12	0	0	0	0	14	0	0	0	0	0	0	0	0	0
Phormium tenax	51475	NZ flax; harakeke	Plants	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0
Digitalis purpurea	4164	Common foxglove	Plants	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0
Aporrectodea rosea	27389	Rosy-tipped earthworm	Worms	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0
Paralemanea annulata	31376		Red algae	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0
Apis mellifera	7460	Bee	Insects	14	0	0	0	0	0	0	0	0	0	0	10	0	0	0
Philodina sp. Pha17	764077		Rotifers	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0
Alchemilla arvensis	57945		Plants	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0
Hydroptilidae sp. 12KH6B	1877717	Purse-case caddisfly	Insects	0	0	7	0	16	0	0	0	0	0	0	0	0	0	0
Deleatidium myzobranchia	1968928	NZ mayfly	Insects	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantago lanceolata	39414	Ribwort plantain; narrowleaf plantain; English plantain; ribleaf; lamb's tongue; buckhorn	Plants	0	0	0	0	0	0	17	0	0	5	0	0	0	0	0
Ulmus parvifolia	63058	Chinese elm	Plants	0	0	0	16	0	0	0	0	6	0	0	0	0	0	0
Brassica oleracea	3712	Wild cabbage	Plants	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0
Juglans regia	51240	English walnut	Plants	0	0	0	0	0	0	0	10	0	0	0	0	0	0	11
Maoridrilus volutus	914182		Worms	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Macrosiphum euphorbiae	13131	Potato aphid	Insects	0	0	0	0	0	21	0	0	0	0	0	0	0	0	0
Bradysia pallipes	1313105		Insects	0	0	9	10	0	0	0	0	0	0	0	0	0	0	0
Penthaleidae sp. Q091	1437083		Mites and ticks	0	0	0	14	0	0	0	0	0	0	0	0	0	5	0
Tupiella sp. BL-2018	2201482		Green algae	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0
Fumaria agraria	1095357		Plants	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0
Tomocerus minor	187706	Springtail	Springtails	9	0	0	0	0	0	0	0	8	0	0	0	0	0	0
Tuberculatus annulatus	527890	Common oak aphid	Insects	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0
Prunus sargentii	97308	Sargent's cherry; North Japanese hill cherry	Plants	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0
Xanthocnemis zealandica	481685	Red damselfly	Insects	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0
Supraphorura furcifera	2041972	Springtail	Springtails	0	9	0	0	0	0	0	7	0	0	0	0	0	0	0
Cerastium alpinum	271556		Plants	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taraperla howesi	1777222	Stonefly	Insects	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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Prunus avium	42229	Gean	Plants	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0
Nitzschia palea	303400	Diatom	Diatoms	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0
Jacksonia papillata	527711		Insects	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnorhina tibicen	9132	Magpie	Birds	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0
Carex appressa	98862	Tall sedge	Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
Dromius meridionalis	1587257	Ground beetle	Insects	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0
Hylurgus ligniperda	167147	Red haired pine bark beetle	Insects	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0
Taraxacum mongolicum	90037		Plants	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0
Pinnularia neomajor	592728	Diatom	Diatoms	5	0	0	0	0	0	0	7	0	0	0	0	0	0	0
Propsocus pulchripennis	1476843	Damp barklouse	Insects	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0
Pittosporum eugenioides	317702	Lemonwood; tarata	Plants	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0
Corynoptera perpusilla	1817629	Fungus gnat	Insects	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0
Deleatidium vernale	1968931	NZ mayfly	Insects	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0
Paropsis charybdis	2037825	Eucalyptus tortoise beetle	Insects	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0
Hordeum brevisubulatum	52155		Plants	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0
Veronica persica	138560	Bird-eye speedwell; Common field-speedwell	Plants	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
Nothophytophthora sp. 'liri'	2796156		Oomycetes	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
Dama dama	30532	Fallow deer	Mammals	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0
Chloroclystis filata	1371973	Filata moth	Insects	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
Wesmaelius subnebulosus	279431	Brown lacewing	Insects	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0
Pythium subutonaiense	2506486		Oomycetes	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0
Bourletiellidae sp. BIOUG16083-F12	2452307		Springtails	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0
Canthocamptidae sp. BOLD:ACJ8158	1679977		Crustaceans	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0
Lagena radicicola	1489789		Oomycetes	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0
Ectopsocus briggsi	322492	Psocopteran fly	Insects	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
Cinara tujafilina	198323	Cypress pine aphid	Insects	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0
Gyraulus corinna	10000037	NZ freshwater snail	Molluscs	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0
Cambridgea ambigua	1304630	New Zealand sheetweb spider; bush spider; pūngāwere; pūngāwerewere; pūwerewere	Spiders	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Planotortrix notophaea	65037	Blacklegged leafroller moth	Insects	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0
Rotaria sp. Rot1	764085	Rotifer	Rotifers	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0
Tachyporus nitidulus	346862		Insects	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0
Endrosis sarcitrella	1073585	White-shouldered house moth	Insects	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0
Tupiella speciosa	2045121		Green algae	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0
Aphanochaete confervicola	764104		Green algae	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0
Ceratophysella gibbosa	187618	Springtail	Springtails	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
Sminthurus viridis	109609	Clover springtail; Lucerne flea	Springtails	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0
Aoteapsyche cf. tipua BR7	599815	NZ caddisfly	Insects	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Scientific Name	Tax ID	Common Name	Group	Site A	Site B	Site C	Site D	Site E	Site F	Site G	Site H	Site I	Site J	Site K	Site L	Site M	Site N	Site O
Oligosoma aff. polychroma clade 4 or 5	10000307	Canterbury or southern grass skink	Lizards	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0
Penthesilenula kohanga	216255		Crustaceans	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0
Cernosvitoviella minor	913641	Worm	Worms	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0
Nysius plebeius	876837		Insects	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0
Stigeoclonium sp.	2943608		Green algae	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
Drepanosiphum platanoidis	527648	Sycamore aphid	Insects	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0
Hoheria lyallii	326350		Plants	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrobiosella stenocerca	177906	Caddisfly	Insects	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psylla apicalis	2044778		Insects	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scaptomyza flava	928822	Turnip leafminer	Insects	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0
Tenuiphantes tenuis	81837	Spider	Spiders	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
Eupodidae sp. BIOUG30372-A02	2455882		Mites and ticks	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0
Taraxacum aff. magellanicum CHR514144	174443		Plants	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
Smynthurodes betae	196486		Insects	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Lithobius microps	1569488		Centipedes	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0
Haplinis diloris	685669	South pacific dwarf spider	Spiders	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
Bryophaenocladius ictericus	1720634		Insects	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cratyna nobilis	1260830		Insects	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eriophora pustulosa	693724	Garden orb weaver spider	Spiders	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
Willowsia nigromaculata	1302335	Springtail	Springtails	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0

C

Appendix C – Site Photos (Rapid Habitat Assessment)

Site Name	Site Photos
Site A	 
Site B	 

Site C

Site D

Site E

Site F

Site G

Site H

Site I

Site J

Site K

Site L

Site M

Site N

Site O