Auckland Tauranga Wellington Christchurch

PATTLE DELAMORE PARTNERS LTD

Tui Mine: Post Remediation Ecological Monitoring 2015

Waikato Regional Council

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Prepared for

Waikato Regional Council

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PATTLE DELAMORE PARTNERS LTD
Level 4, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 **523 6900** Fax +64 9 **523 6901**
Website **http://www.pdp.co.nz**
Auckland Tauranga Wellington Christchurch

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DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Patrick Lees

Reviewed by

SIGNATURE

Mary Beech

Approved by

Keith Delamore

Limitations:

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Executive Summary

Waikato Regional Council (WRC) has commissioned Pattle Delamore Partners Ltd (PDP) to undertake environmental monitoring pre and post mine remediation of Tui Mine, Te Aroha in the Tui and Tunakohoia Streams. This report presents results from ecological monitoring in 2015, six years on from the baseline study conducted by Coffey (2009) and 2 years on from the post-remediation study conducted by PDP (2013).

Macroinvertebrate community results for the un-impacted (control) sites above the mine discharge (Tui Stream and Tunakohoia Stream south branch) were similar to those sites for the baseline 2009 survey and the post remediation study in 2013. Both un-impacted sites scored in the representative macroinvertebrate community index category 'excellent', indicating a healthy aquatic macroinvertebrate community. The 2015 results showed that a continued improvement in macroinvertebrate health at the two impacted sites (Tui Stream and Tunakohoia Stream north branch downstream of discharge) compared to the 2009 baseline study (Coffey 2009). The macroinvertebrate community in 2009 was virtually absent, whereas in 2013 and 2015, taxonomic richness and abundance have increased considerably, scoring in the "good" and "excellent" categories for macroinvertebrate community index.

Based upon the findings of ecological monitoring conducted in 2015, macroinvertebrate communities at the impacted sites, that receive mine discharges (Tui Stream and Tunakohoia Stream north branch) are still affected by past and/or present activities at the Tui Mine, but to a lesser extent than recorded in 2009. There has been an overall improvement observed at both the impacted and un-impacted sites, represented by increased taxa richness, diversity, abundance and improved community composition. The 2015 habitat monitoring results show that the in-stream, riparian and bankside habitat is consistent with results from 2013.

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1.0 Overview

Pattle Delamore Partners Limited (PDP) was commissioned by Waikato Regional Council (WRC) to undertake progress monitoring of the Tui and Tunakohoia Streams in the vicinity of the Tui mine (Figure 1) post remediation.

Previous water quality (PDP, 2010; PDP, 2012; PDP, 2014) and ecology (Coffey, 2009; PDP, 2013) reports have noted:

- Good water quality and ecosystem health in the Tui stream and the southern branch of the Tunakohoia Stream above the discharge from the mine.
- Water highly contaminated with heavy metals below the mine discharge in Tui stream and in the northern branch of the Tunakohoia Stream. In-stream ecological health was low in these areas, and was unable to support a significant or diverse macroinvertebrate community.
- However, there has been an overall improvement in macroinvertebrate diversity, abundance and community composition at both the impacted and un-impacted sites

The current work undertaken by PDP has included the analysis and interpretation of ecosystem health from the collection of macroinvertebrates, water quality, and habitat assessment data.

This report presents the results of the ecological monitoring carried out in October 2015.

2.0 Introduction

Freshwater macroinvertebrates are a widely used biological indicator of stream health as they can adequately reflect several anthropological and environmental pressures such as pollution, hydrological and geomorphological changes and are also widely distributed and provide relatively cost effective results (Stark, 1998; Boothroyd and Stark, 2000; Stark and Maxted, 2007; and Álvarez-Cabria *et al*., 2010). However, in systems receiving Acid Mine Drainage (AMD; also known as acid rock drainage) such as from the Tui Mine, the chemical characteristics of the mine waters are of overriding importance and can strongly influence macroinvertebrate community composition (Harding, 2005; Lefcort *et al.,* 2010).

3.0 Methods

3.1 Ecological Sampling Procedures

Ecological monitoring was undertaken within the Tunakohoia and Tui Streams at four sampling locations: un-impacted Tui Stream (upstream of tailings discharge; SW12), impacted Tui Stream (downstream of discharge; SW13), un-impacted

Tunakohoia Stream (south branch above north branch confluence; SW8) and impacted Tunakohoia Stream (north branch below discharge; SW7) (Table 1; Appendix A; Figure 1).

Table 1: Tui Baseline Monitoring Sites

Site ID	Site Name	State	Site Description	Monitoring
SW12	Tui Stream	Un-impacted	Tui Stream, upstream of tailings discharge.	Ecology & Water Quality
SW13	Tui Stream	Impacted	Tui Stream, downstream of tailings discharge upstream of ford and culverts.	Ecology & Water Quality
SW8	Tunakohoia Stream	Un-impacted	Tunakohoia Stream south branch, upstream of north branch confluence, town water supply inlet.	Ecology & Water Quality
SW7	Tunakohoia Stream	Impacted	Tunakohoia Stream north branch, upstream of south branch confluence and downstream of tailings dam.	Ecology & Water Quality

Ecological and water quality sampling was undertaken in October 2015. For consistency and comparison of results, ecosystem health sampling was carried out in accordance with sampling locations and methodologies used by Coffey (2009) and PDP (2013).

In brief, macroinvertebrates were collected semi-quantitatively using a long-handled D-net (kick net) with a 500 *u*m mesh net. An area of approximately 3 m^2 was sampled and the proportion of habitat types sampled was recorded on field assessment cover forms. Four replicates were collected at each site to allow for the detection of statistically significant differences in macroinvertebrates. The macroinvertebrate samples were preserved in the field for later processing and analysis. Sampling was conducted in accordance with established guidelines (e.g., Stark *et al*, 2001; Collier and Kelly, 2005).

Macroinvertebrate samples were sent to Stark Environmental Limited for identification, where a 200 individual fixed count with a scan for rare taxa for each macroinvertebrate sample was undertaken (as per Stark *et al.*, 2001; Collier and Kelly, 2005).

Water quality parameters (temperature, conductivity, dissolved oxygen and pH) were measured at each ecological monitoring site using calibrated field meters. This information will be presented in an accompanying water quality report.

Habitat assessments were conducted at each of the four sites using field habitat assessment forms for hard bottom streams (Collier and Kelly 2005). Habitat scores were very similar to that of 2009 and 2013. However, the 2015 results show that there appeared to be less visible periphyton at all sites sampled. Given there have been no notable changes, the habitat data has not been presented in this report. For reference to habitat assessments see Coffey (2009).

3.2 Statistical Analysis of the Data

A variety of individual metrics were used to assess the relative health of the macroinvertebrate communities at each site. The total number of invertebrates, taxonomic richness, Macroinvertebrate Community Index (MCI), Quantitative Macroinvertebrate Community Index (QMCI), percent of Ephemeroptera, Plecoptera, Trichoptera (%EPT), and Acid Mine Drainage Index (AMDI) were assessed for each site (Table 2).

T-tests were performed to test whether there were any significant differences ($P = <0.05$) between the un-impacted and impacted site indices data and between the 2013 and 2015 indices data. Species were also reduced to broad taxonomic groups for the assessment of relative abundances of the taxa groups at each site (presented as % bar graph; Appendix C; Figure 3).

Table 2: Macroinvertebrate Metrics

Metric	Definition
Taxa Richness	Indicates the number of species present. Streams supporting high numbers of taxa generally indicate healthy communities.
MCI	This index allocates macroinvertebrate taxa a score between 1 (pollution tolerant) and 10 (pollution intolerant) depending on each taxon's tolerance to organic enrichment and is based on presence/absence data. Interpretation of MCI values as follows: >120 = Excellent, 100-120 = Good, 80-100 = Fair and <80 = poor.
QMCI	This index allocates macroinvertebrate taxa a score between 1 (pollution tolerant) and 10 (pollution intolerant) depending on each taxon's tolerance to organic enrichment. These scores are multiplied by the abundance of the taxa and divided by the total abundance then combined to give an overall QMCI value. Stark (1998) provided an interpretation of QMCI values as follows: >6 = clean water (Excellent), 5-6 =doubtful quality of possible mild degradation (Good), 5-4 = probable moderate degradation (Fair) and <4 = probable severe degradation (Poor).

Table 2: Macroinvertebrate Metrics	
Metric	**Definition**
%EPT	Measures the number of sensitive taxa belonging to Ephemeroptera, Plecoptera and Trichoptera orders as a percent of total taxa identified (excluding the pollution tolerant genera *Oxyethiria* and *Paroxyethira*[1]).
AMDI	The Acid Mine Drainage Index (AMDI) is similar to MCI, but is calibrated for water with AMD. AMDI has been developed by associating water chemistry and benthic invertebrate community data (Gray and Harding 2012) to develop taxa specific indicator scores. AMD Index is defined by 3 categories, <20 = impacted by AMD, 20-40 = moderately impacted by AMD and >40 = un-impacted by AMD.

4.0 Results and Discussion

The presence and relative abundance of macroinvertebrates as measured at the sites, together with calculated metrics of macroinvertebrate community structure are provided in Appendix B.

4.1 Macroinvertebrate Health and Indices

Macroinvertebrate health results from both un-impacted sites (SW12 and SW8) were similar to that of the baseline study by Coffey (2009) and post remediation monitoring by PDP (2013), scoring "excellent" MCI and QMCI values (Table 3). This indicates that both the un-impacted Tui and Tunakohoia streams have high in-stream habitat quality and water quality that allows for a diverse aquatic macroinvertebrate community (Figure 2 and 3 Appendix C).

4.1.1 Tunakohoia Stream

The calculated MCI scores from the un-impacted Tunakohoia Stream Site (SW8) were significantly higher than the impacted Tunakohoia Stream site (SW7) in 2015 ($p = 0.003$). There were no significant differences between the 2015 and 2013 Tunakohoia Stream MCI scores at both the un-impacted site (SW8) and the impacted site (SW7). The Tunakohoia Stream QMCI values were not significantly higher at SW8 than at SW7. There were no significant differences in QMCI values between the 2015 and 2013 results from both sites on the Tunakohoia Stream.

[1] Both *Oxyethira* and *Paraoxyethira* are common *Hydroptilidae* caddisfly taxa that are able to withstand habitats with increased nutrient enrichment, algae bio mass and low shade. Their removal from the percent EPT taxa calculation enables this metric to represent the proportion of EPT taxa that are sensitive to pollution and degraded environments.

4.1.2 Tui Stream

Calculated MCI scores from Tui Stream were not significantly different between the un-impacted site (SW12) and the impacted site (SW13) in 2015. There were no significant differences between the 2015 and 2013 Tui Stream MCI scores at both the un-impacted (SW12) and impacted sites (SW13). The Tui Stream QMCI values were not significantly higher at SW12 than at SW13. There were no significant differences in QMCI values between 2015 and 2013 results from both sites on the Tui Stream. However, there was a reduction in the average QMCI value at the impacted Tui Stream site (SW13) from 2013 to 2015 (Table 3). The decrease in average QMCI value can be attributed to one replicate sample (SW13 Replicate No. 2 QMCI = 5 (Appendix B)) only having one identified net spinning caddisfly *Orthopsyche* (MCI value = 9), while the other three replicates ranged from 20 – 67 *Orthopsyche* individuals identified.

The current MCI scores generally indicate that the in-stream habitat quality for aquatic macroinvertebrates is high across all sites, however mayflies (Ephemeroptera) continue to be absent from both the impacted sites (Appendix B). The likely reason for absence of mayflies at the impacted sites is not yet known.

The 2015 results were an improvement on the 2009 results (Coffey, 2009). MCI and QMCI health scores at the impacted site in Tui Stream continued to be classed as 'excellent' in 2015. The impacted site in the Tunakohoia Stream continued to be classed as 'good' for MCI and 'excellent' for QMCI in 2015 (Table 3).

The %EPT values obtained from the 2015 sampling were not significantly different between the impacted and un-impacted sites in Tui Stream. However, %EPT values were significantly different between the impacted and un-impacted sites on the Tunakohoia Stream ($p = 0.0013$,). Likewise, only the 2015 impacted Tunakohoia Stream %EPT values were significantly different from the 2013 results ($p = 0.027$).

4.2 Invertebrate Richness and Abundance

Average taxonomic richness at the two un-impacted sites continued to be similar to previous sampling rounds (Table 3). Average taxonomic richness either increased (SW13) or remained stable (SW7) at both impacted sites in 2015 compared with 2009 and 2013 results. Taxonomic richness was significantly higher at the un-impacted sites compared to the impacted sites in the 2015 monitoring, in the Tui Stream ($p = 0.007$) and the Tunakohoia Stream ($p = 0.002$).

Average macroinvertebrate abundance at both un-impacted sites was high. Macroinvertebrate abundance at Tunakohoia Stream was similar to that observed in 2009, while 2015 macroinvertebrate abundance at the un-impacted Tui Stream site was less than both the 2009 and 2013 results. The Tui Stream un-

impacted site site generally showed higher abundances than the un-impacted site on the Tunakohoia Stream (Table 3).

Abundance at the two impacted sites in 2015 was greater than that observed in the 2009 sampling (Table 3), but lower than that observed in 2013 (95 to 80 individuals at the impacted site on Tui Stream and 38 to 29 individuals at the impacted site on Tunakohoia Stream). Although abundance has increased since remediation, the abundances are still low and less than 50% of the un-impacted site.

4.3 Acid Mine Drainage Index

Macroinvertebrate AMDI results from 2015 indicate that the two un-impacted sites are un-impacted by AMD, as expected.

The impacted Tunakohoia Stream site (SW7) had a similar AMDI score to 2013, while the impacted Tui Stream site (SW13) increased to 42 (Table 3). An AMDI score of 42 indicates that the impacted Tui Stream site (SW13) is just within the boundaries of being classed as un-impacted (i.e., AMDI score > 40 = un-impacted). It is important to note that this is the first sample to indicate that this site has "recovered" from the effects of AMD. But caution should be used as there is inherent variability in macroinvertebrate community composition at this site. The site won't be considered to have "recovered" until AMDI tolerance scores are +/- 10% of the control sites consistently.

AMDI scores were significantly different at the un-impacted sites compared to the impacted sites in Tui Stream ($p = 0.006$) and in the Tunakohoia Stream ($p = 0.005$).

4.4 Community Composition

Caddisfly (Trichoptera), especially from the family Hydropsyche (*Orthopsyche* and *Aoteapsyche*) appear to be the dominant taxa across all sites, only the un-impacted Tunakohoia Stream site appeared to have a lower composition of caddisfly larva (Figure 3, Appendix C). Mayfly (Ephemeroptera) and stonefly (Plecoptera) larvae were also abundant at the un-impacted sites and made up between 10-30% of the community (Figure 3; Appendix C). Greater diversity was observed at the two un-impacted sites, represented by increased taxonomic richness and high abundances of each taxa. Freshwater Koura were observed during sampling at the un-impacted site on Tunakohoia Stream (SW8), further suggesting good ecosystem health and aquatic diversity in the upper reaches un-affected by the mine discharge.

Although there have been improvements compared with the situation reported in Coffey (2009), the macroinvertebrate communities at the two impacted sites are generally dominated by 1 macroinvertebrate order in 2015. Caddisflies made up 49% of the sample from the impacted site on Tui Stream and 50% of the

sample at the impacted Tunakohoia Stream site. Secondarily Diptera (or true flies) were prominently identified at the impacted Tunakohoia Stream site in 2015 (Appendix C; Figure 3). Communities dominated by a few taxa generally indicates a level of environmental stress.

Of interest is the increase in abundance of Dipteran taxa at both the impacted sites between 2013 and 2015 (Appendix C; Figure 3). This can be attributed to an increase in the occurrence of *Aphrophila spp* (a species of crane fly). *Aphrophila spp* has a high AMD value meaning that it is susceptible to effects associated with AMD, and is therefore not usually a common species within streams with such conditions. *Aphrophila spp* were identified in low numbers in 2013, and have become abundant within impacted samples in 2015 (22 individuals identified in Tunakohoia Stream (SW7) and 86 individuals identified in Tui Stream (SW13)).

Table 3: Summary Table: Average Macroinvertebrate Results

	SW12			SW13			SW8			SW7		
	Unimpacted: Tui Stream			Impacted: Tui Stream			Unimpacted: Tunakohoia Stream			Impacted: Tunakohoia Stream		
	2009	2013	2015	2009	2013	2015	2009	2013	2015	2009	2013	2015
Taxa Richness	23 (1.15)	23 (4.27)	21 (3.37)	2 (0.5)	7 (1.26)	11(1.71)	19 (0.5)	19 (4.19)	20 (2.22)	2 (1.29)	8 (0.5)	8 (2.63)
# Inverts	202 (1.63)	195 (43.9)	167 (62.9)	2 (0.82)	95 (32.6)	80 (30.5)	136 (0.82)	140 (64.1)	144 (39.3)	2 (1.29)	38 (14.1)	29 (28.6)
MCI	142 (2.15)	145 (5.35)	145 (5.92)	n/a	131 (4.19)	133 (13.3)	136 (3.5)	149 (10.8)	145 (6.13)	n/a	110 (13.0)	117 (3.32)
QMCI	6 (0.11)	8 (0)	8 (0.82)	n/a	8 (0.5)	6 (0.96)	6 (0.17)	8 (0.58)	7 (0.5)	n/a	6 (0.5)	7 (0.96)
%EPT taxa	n/a	61 (4.57)	58 (4.20)	n/a	61 (22.1)	51 (6.70)	n/a	69 (6.45)	66 (6.18)	n/a	29 (13.5)	45 (5.74)
AMDI	n/a	64 (4.43)	64 (4.80)	n/a	36 (3.87)	42 (11.5)	n/a	75 (5.97)	73 (5.10)	n/a	36 (9.5)	35 (7.93)

Notes:

a) n/a – indices not calculated due to insufficient number of species present within sample.

b) Values in parentheses indicate the standard deviation.

Key: Stream Health Score Card		
MCI <80	Poor	QMCI < 4.00
MCI 80-100	Fair	QMCI 4.00 - 5.00
MCI 100-120	Good	QMCI 5.00 - 6.00
MCI>120	Excellent	QMCI > 6.00

Key: Acid Mine Drainage Index
AMDI < 20 = impacted by acid mine drainage
AMDI 20 - 40 = moderately impact by AMD
AMDI > 40 = unimpacted

5.0 Summary

Ecological monitoring was undertaken within the Tui and Tunakohoia Streams at four sampling locations, un-impacted Tui Stream (upstream of tailings discharge; SW12), impacted Tui Stream (downstream of discharge; SW13), un-impacted Tunakohoia Stream (south branch above north branch confluence; SW8) and impacted Tunakohoia Stream (north branch below discharge; SW7) (Table 1; Figure 1 Appendix A).

All four monitoring sites were physically similar hard-bottomed habitats. Healthy aquatic macroinvertebrates were observed at the un-impacted control sites along the Tui Stream and the Tunakohoia Stream south branch. In previous sampling by Coffey (2009), healthy macroinvertebrate communities were not observed downstream of the tailings and mine discharges in the Tui Stream and the Tunakohoia Stream north branch (the impacted sites), in fact they were virtually non-existent. However, repeat surveys four and six years on have demonstrated a notable improvement in the macroinvertebrate community.

Macroinvertebrate index scores and taxonomic richness increased at both impact sites between 2013 - 2015:

Impacted Tui Stream (2013 - 2015):

- AMDI scores indicate this site has improved from “moderately’ impacted by AMD to un-impacted by AMD (although care should be taken when classifying the site as un-impacted).
- An increase in the number of identified Dipteran species, especially *Aphrophila spp*.
- Average taxonomic richness increased from 7 to 11 taxa, and macroinvertebrate abundance remained higher than 2009 results.

Impacted Tunakohoia Stream (2013 - 2015):

- AMDI scores indicate this sites is still “moderately’ impacted by AMD.
- An increase in the number of identified Dipteran species, especially *Aphrophila spp*.
- Average taxonomic richness remained at 8 taxa, and macroinvertebrate abundance remained higher than 2009 results.

The improved MCI scores (over baseline monitoring conducted in 2009) generally indicate that the macroinvertebrate quality and community isn’t limited by habitat, but may be limited by other water quality issues (e.g., AMD). Mayflies (Ephemeroptera) were still absent from the impacted sites (Appendix B; Figure 3). The likely reason for absence of mayflies at the impacted sites is not yet understood.

It is positive to see an improvement at the impacted sites, particularly with regards to the presence of the stonefly *Acroperla trivacuata* and *Stenoperla spp*, the caddisfly *Hydropsyche* and the dipteran *Aphrophila sp*. However, species of stoneflies and caddisflies are known to tolerate lower pH and higher heavy metal concentrations than some other aquatic taxa (Gray and Harding, 2012). As the more sensitive taxa to heavy metal concentrations and fluctuations in pH, such as some mayfly species (Hickey and Golding, 2002; Sutcliffe and Hildrew, 1989), are still absent from the impact sites, this potentially indicates some level of continued environmental stress.

The improvement in macroinvertebrate community health in the Tui and Tunakohoia Streams (below the Tui mine discharge) is likely attributed to remediation efforts and the associated improvement of instream water quality conditions. The findings in this report now need to be correlated with results of water quality sampling conducted by PDP to further explore causations / likely reasons for the observed improvement in macroinvertebrate health.

6.0 Recommendations

- Given the notable improvement in macroinvertebrate health at the two impacted sites, it is recommended that ecological monitoring of macroinvertebrate health be continued to track remediation progress. Although improvements in aquatic health have been observed, abundance and taxonomic richness are still significantly lower in the impacted sites when compared to the un-impacted control sites. This indicates that the community has not yet returned to its pre mine discharge state.
- Seasonal changes (climatic condition) and stages of macroinvertebrate life cycles can have a significant influence on presence/absence of taxa. It is therefore recommended that a summer sampling survey be conducted to monitor seasonal changes.

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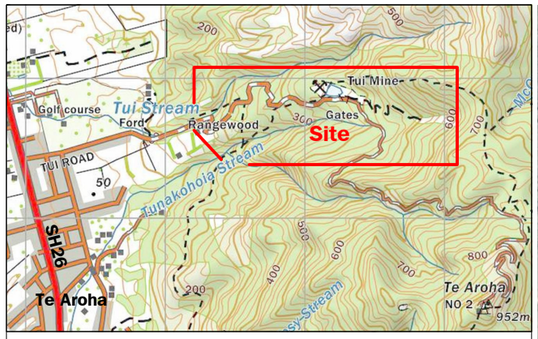
Appendix A

Sample Locations



SITE LOCATION

Source: Aerial imagery derived from Google Earth Pro (may not be spatially accurate).
Cadastral Map derived from LINZ data.

Figure 1 : TUI MINE BASELINE MONITORING LOCATIONS MAP

A02277803D001.dwg [A02277600I001.jpg] Dec-13 Final

Appendix B

Macroinvertebrate Composition and Metrics and Habitat Field Assessment Forms

Table 1: Macroinvertebrate Identification and summary statistics

200 Fixed Count with scan for rare taxa			SW7				SW8				SW12				SW13			
			15-Oct-15				15-Oct-15				15-Oct-15				15-Oct-15			
TAXA	MCI	AMDI	#1	#2	#3	#4	#1	#2	#3	#4	#1	#2	#3	#4	#1	#2	#3	#4
Mayflies	score	score																
Acanthophlebia cruentata	7	-	-	-	-	-	-	-	-	-	4	-	1	8	-	-	-	-
Ameletopsis perscitus	10	6	-	-	-	-	1	2	-	1	-	-	-	1	-	-	-	-
Austroclima sepia	9	4	-	-	-	-	-	2	-	3	1	1	7	1	-	-	-	-
Coloburiscus humeralis	9	8	-	-	-	-	1	38	1	39	3	5	5	-	-	-	-	-
Deleatidium spp.	8	6	-	-	-	-	74	15	43	-	15	17	34	22	-	-	-	-
Nesameletus spp.	9	9	-	-	-	-	2	-	4	-	-	1	-	1	-	-	-	-
Zephlebia dentata	7	9	-	-	-	-	1	1	-	4	1	2	4	-	-	-	-	-
Zephlebia versicolor	7	9	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-
Zephlebia spp.	7	9	-	-	-	-	3	-	2	-	1	4	23	1	-	-	-	-
Stoneflies																		
Acroperla trivacuata	5	-	-	-	-	-	-	5	-	15	-	-	-	-	6	3	3	11
Austroperla cyrene	9	0	-	-	-	-	-	-	-	3	5	2	3	-	-	-	-	-
Megaleptoperla grandis	9	9	-	-	-	-	1	5	2	2	1	-	-	-	-	-	-	-
Spaniocerca sp.	8	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Stenoperla prasina	10	7	2	2	2	2	1	2	-	1	3	-	2	-	3	3	1	1
Stenoperla sp.	10	7	4	1	1	1	1	3	3	-	6	1	-	3	1	-	-	-
Taraperla pseudocyrene	7	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zelandobius confusus group	5	0	-	-	-	-	6	54	28	29	8	2	9	3	-	1	5	-
Zelandoperla agnetis	10	4	-	-	-	-	-	1	4	10	5	86	1	-	-	-	-	-
Zelandoperla decorata	10	4	-	-	-	1	-	-	-	-	-	-	-	-	2	-	2	-
Dobsonflies																		
Archichauliodes diversus	7	2	-	-	-	-	2	1	5	6	-	-	-	-	-	-	2	-
Beetles																		
Elmidae	6	0	1	-	-	-	-	-	1	-	18	2	2	5	-	-	1	-
Hydraenidae	8	5	-	-	-	-	-	1	1	1	9	2	1	2	-	-	-	-
Hydrophilidae	5	8	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Ptilodactylidae	8	10	-	-	-	-	-	-	-	3	1	3	1	2	-	1	-	-
True Flies																		
Aphrophila spp.	5	8	-	1	4	17	-	5	1	2	-	-	-	-	19	10	30	27
Empididae	3	5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Eriopterini	9	3	-	-	-	-	-	1	1	-	2	2	-	3	1	-	1	7
Hexatomini	5	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-
Limonia nigrescens	6	7	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Maoridiamesa spp.	3	0	2	1	1	12	-	-	-	-	-	-	-	-	5	7	8	-
Molophilus sp.	5	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Neocurupira sp.	7	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Paralimnophila sp.	6	6	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Orthocladiinae	2	0	-	-	-	-	-	-	1	4	-	-	-	-	4	5	-	1
Polypedilum spp.	3	0	-	-	-	-	-	2	-	3	-	-	-	-	-	3	-	2
Stictocladius sp.	8	0	-	-	-	-	-	-	-	-	7	1	-	3	-	-	-	-
Tabanidae	3	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Tanypodinae	5	0	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Tanytarsus funebris	3	0	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-
Caddisflies																		
Costachorema hecton	7	9	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Costachorema sp.	7	9	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Helicopsyche sp.	10	8	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Hydrobiosella mixta	9	7	-	-	-	-	-	-	2	8	1	1	12	-	-	-	-	2
Hydrobiosis spatulata	5	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Hydrochorema sp.	9	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
Continued...																		

Table 1: Macroinvertebrate Identification and summary statistics continued..

200 Fixed Count with scan for rare taxa			SW7				SW8				SW12				SW13			
			15-Oct-15				15-Oct-15				15-Oct-15				15-Oct-15			
TAXA	**MCI**	**AMDI**	**#1**	**#2**	**#3**	**#4**	**#1**	**#2**	**#3**	**#4**	**#1**	**#2**	**#3**	**#4**	**#1**	**#2**	**#3**	**#4**
Caddisflies																		
Hydropsyche - Aoteapsyche group	9	5	-	-	-	-	-	1	1	3	-	-	-	-	-	-	1	-
Hydropsyche - Orthopsyche group	9	5	2	-	5	24	-	32	8	26	93	44	81	3	67	1	20	37
Polyplectropus sp.	8	4	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Pycnocentrodes spp.	5	0	-	-	7	8	1	-	-	-	-	-	-	-	-	1	2	-
Crustacea																		
Paranephrops planifrons	5	10	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-
Collembola	6	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Mites	**5**	**-**	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Flabellifrontipoda sp.	**5**	**-**	1	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
Oribatidae	5	-	2	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-
Worms	1	1	-	-	-	-	-	-	-	6	1	1	1	-	-	-	-	-
Flatworms	**3**	**-**	2	-	1	3	-	-	-	-	1	-	-	1	-	-	-	-
Snails																		
Potamopyrgus antipodarum	4	10	-	-	-	-	2	3	10	9	18	15	3	10	4	-	-	-
SUMMARY STATISTICS																		
Total number of taxa (incl. rare taxa)			8	4	9	10	17	21	21	22	26	19	20	19	11	13	12	9
Number of rare taxa			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of individuals			16	5	23	70	101	176	121	179	208	192	194	73	113	40	76	89
MCI tolerance score			117	120	113	120	141	151	150	139	140	153	141	144	145	114	138	133
QMCI tolerance score			7	8	6	6	8	7	7	7	8	9	8	7	7	5	6	7
%EPT taxa			38	50	44	50	71	71	62	59	58	63	60	53	45	46	58	56
%EPT abundance			50	60	65	51	93	93	83	80	71	86	94	60	70	25	45	58
AMDI			27	33	35	46	78	75	73	66	71	65	62	60	57	42	29	41

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Field Assessment Form: Wadeable Streams

Job Number: A02277813	**Job Name:** Tui Ecology	**Assessor:** AG + PL
Location: Tui	**Date:** 15.10.15	**Time (NZST):** 12.45pm
Site Number: SW7	**Easting:** 1840449	**Northing:** 5843485

Channel and Riparian Features

Canopy Cover		Dom Riparian Veg		Fencing	
Open		Crops		None of ineffective	X
Partly Shaded		Pasture		One side or partial	
Significantly Shaded	X	Exotic Trees		Complete both sides	
		Native Shrubs	X		

Instream Hydraulic Conditions

Ave. Stream width (active channel)	4.5	Ave Stream depth	0.12-0.17
Max. Stream width (active channel)	4.7	Max Stream depth	0.26
Ave. Stream width (water)	1.175	Ave. Surface velocity	
Max Stream width (water)	3.6		

Water Quality

Temperature (C): 10.8 Conductivity: 310 sec us/cm DO (mg/L): 101.3 DO (%): 8.922

pH = 9.23
ORP -33.8

Turbidity

Clear:	✓	Highly Turbid:	
Slightly Turbid:		Other:	

Stream-Bottom Substrata

Compaction (inorganic substrata):		
Assorted sizes tightly packed &/or overlapping composition	X	Some loose gravel but still well sorted & lacking silt
Moderately packed with some overlap		
Mostly a loose assortment with little overlap		
No packing/loose assortment easily moved		

Embeddedness (% gravel-boulder particles covered by fine sediment):						
<5%	✓	5-25%		26-50%		
51-75%		>75%				

Organic Material (% cover*)						
Large wood (>10cm diameter)						
<5%		5-25%	X	26-50%		
51-75%		>75%				
Coarse Detritus (small wood, sticks, leaves etc)						
<5%		5-25%	X	26- 50%		
51-75%		>75%				
Fine (<1mm) Organic Deposits (edges & backwaters)						
<5%	X	5-25%		26-50%		
51-75%		>75%				

Habitat Types Sampled (for macroinvertebrates, % effort: each column)

(% of effort; should sum to 100%

Riffle	70	Run	30	Total%	100
Stones:	80	Wood	15		
Edges	5	Macrophytes		Total%	100

Comments

See pals iPhone

Photo Numbers:

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QUALITATIVE HABITAT FIELD SHEET:

WADEABLE HARD BOTTOMED STREAMS

Job Name: Tui Ecology	**PDP Job # :** A02277813	**Date:** 15.10.15	**Time (NZST)**
Location:	**Site Name:** Tunakohoia	**Assessor:** AG + PL	**Easting:**
Site id: SW7			**Northing:**

Habitat Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Riparian Vegetative Zone Width	• Bankside vegetation buffer > 10 m • Continuous and dense	• Bankside vegetation buffer < 10 m • Mostly continuous	• Pathways present and /or stock access to stream • Mostly healed over	• Break frequent • Human activity obvious
Left Bank	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right Bank	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB & RB				
2. Vegetative Zone Protection	• Bank surfaces and immediate riparian zones covered by native vegetation • Trees, understory shrubs or non woody plants present • Vegetation disruption minimal	• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forest	• Bank surfaces covered by a mixture of grasses, shrubs, blackberry, willow and introduced trees • Vegetation disruption obvious • Bare soil/closely cropped vegetation common	• Bank surfaces covered by grasses and shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to the bank
Left Bank	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right Bank	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB & RB				
Stability	• Banks stable • Erosion/bank failure absent or minimal • < 5 % of bank affected	• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5 - 30 % of bank eroded	• Moderately unstable • 30 - 60% of bank in reach has areas of erosion • High erosion potential during floods	• Unstable • Many eroded areas • 60 - 100 % of bank has erosional scars
Left Bank	20 19 18 17 16	15 (14) (13) 12 11	10 9 8 7 6	5 4 3 2 1
Right Bank	20 19 18 17 16	(15) (14) 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB & RB				
4. Frequency of Riffles	• Riffles relatively frequent • Disturbance between riffles divided by width of stream = 5 - 7 • Variety of habitat is key	• Occurrence of riffles infrequer • Distance between riffles divided by width of stream = 7 - 15	• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by width of stream = 15 - 25	• Generally flat water shallow riffles • Poor habitat • Distance between riffles divided by width of stream = > 25
Score ___	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Subtotal ___				
5. Channel Alteration	• Changes to channel/dredging absent or minimal • Stream with normal pattern	• Some changes to channel dredging • Evidence of past channel dredging • Recent channel dredging not present	• Channel changes/dredging extensive • Embankments or shoring structures present on both banks • 40 - 80 % of the reach channelised and disturbed	• Banks shored with gabion or cement • > 80 % of the stream reach channelised and disturbed • Instream habitat altered or absent
Score ___	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

QUALITATIVE HABITAT FIELD SHEET:

WADEABLE HARD BOTTOMED STREAMS

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
6. Sediment Deposition	• Little/no islands or point bars present • < 20 % of the bottom affec by stream deposition	• New increase in bar formatio mostly from gravel, sand or fine sediment • 20 - 50 % of bottom affected • Slight deposition in pools	• Some deposition of new gravel sand or fine sediment on old and new bars • 50 - 80 % of the bottom affected • Sediment deposits at obstructi constructions and bends	• Heavy deposits of fine material • Increased bar development • > 80 % of the bottom changing frequently • Pools almost absent due to sediment deposition
Score ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Velocity/Depth Regimes	• 4 velocity/depth regimes pre • Slow/deep, slow/shallow Fast/shallow, Fast/deep	• 3 of 4 velocity/depth regimes • If fast/shallow is missing then score lower	• 2 of 4 velocity/depth regimes • If fast/shallow or slow/shallow is missing then score lower	• Dominated by 1 velocity/ depth regime • Usually slow/deep
Score ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Abundance and Diversity of Habitat	• > 50 % substrate favourable for invert colonisation, wide va of woody debris, riffles, root m • Snags/submerged logs/under cut banks/cobbles provides abundant fish cover • Must not be new or transien	• 30 - 50 % substrate favourab for invertebrate colonisation • Snags/submerged logs/under-cut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material	• 10 - 30 % substrate favourabl for invertebrate colonisation • Fish cover patchy • 60 - 90 % substrate easily mo by foot • Woody debris rare or may be smothered by sediment.	• < 10 % substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or or limited to macrophytes
Score ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
9. Periphyton	• Periphyton not visible on har held stones • Stable substrate • Surfaces rough to touch	• Periphyton not visible on ston • Stable substrate • Periphyton obvious to touch	• Periphyton visible • < 20 % cover of available sub	• Periphyton obvious and prolific • > 20 % cover of available substrate
Score ___	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
TOTAL SCORE ___	Note: Only use means of LB and RB values			

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Field Assessment Form: Wadeable Streams

Job Number: A02277813	**Job Name:** Tui Ecology	**Assessor:** AG + PL
Location: Tunakohoia	**Date:** 15/10/15	**Time (NZST):** 1151
Site Number: SW8	**Easting:** 1840464	**Northing:** 5843432

Channel and Riparian Features

Canopy Cover		Dom Riparian Veg		Fencing	
Open		Crops		None of ineffective	✓
Partly Shaded	✓	Pasture		One side or partial	
Significantly Shaded		Exotic Trees		Complete both sides	
		Native Shrubs	✓		

'110', 5+194, '220, '110, +40 + 50

Instream Hydraulic Conditions

Ave. Stream width (active channel)	2.25m	Ave Stream depth	.107 m
Max. Stream width (active channel)	4.1 m	Max Stream depth	.220 m
Ave. Stream width (water)	1.9 m	Ave. Surface velocity	
Max Stream width (water)	See notes		

Water Quality

Temperature (C): 10.3 Conductivity: 81.1 DO (mg/L): 8.87 DO (%): 99.3

pH = 7.24

ORP = 226.2

Turbidity

Clear:	✓	Highly Turbid:	
Slightly Turbid:		Other:	

Stream-Bottom Substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping composition	X	
Moderately packed with some overlap		
Mostly a loose assortment with little overlap		
No packing/loose assortment easily moved		

Embeddedness (% gravel-boulder particles covered by fine sediment):

<5%	X	5-25%		26-50%			
51-75%		>75%					

Organic Material (% cover*)

see note

Large wood (>10cm diameter)

<5%	X	5-25%		26-50%			
51-75%		>75%					

Coarse Detritus (small wood, sticks, leaves etc)

<5%	X	5-25%		26- 50%			
51-75%		>75%					

Fine (<1mm) Organic Deposits (edges & backwaters)

<5%		5-25%	X	26-50%			
51-75%		>75%					

Habitat Types Sampled (for macroinvertebrates, % effort: each column)

(% of effort; should sum to 100%

Riffle	30	Run	70	Total%	100
Stones:	~~40~~ 85	Wood	15		
Edges		Macrophytes		Total%	100

Comments

Instream high habitat diversity - ave stream width rough indication - 4 runs ave.

Photo Numbers: Stenoperla in large cobbles, Zelandoperla sp

- large tree blocking u/s not including as will sway 1/2 yes

- Koura (crayfish) ~5cm

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QUALITATIVE HABITAT FIELD SHEET:
WADEABLE HARD BOTTOMED STREAMS

Job Name: Tui Ecology	**PDP Job # :** A02277813	**Date:** 15.10.15	**Time (NZST)**
Location:	**Site Name:** Tunakohoia	**Assessor:** AG + PL	**Easting:**
Site id: SW 8			**Northing:**

Habitat Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Riparian Vegetative Zone Width	• Bankside vegetation buffer > 10 m • Continuous and dense	• Bankside vegetation buffer < 10 m • Mostly continuous	• Pathways present and /or stock access to stream • Mostly healed over	• Break frequent • Human activity obvious
Left Bank	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right Bank	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB & RB				
2. Vegetative Zone Protection	• Bank surfaces and immediate riparian zones covered by native vegetation • Trees, understory shrubs or non woody plants present • Vegetation disruption minimal	• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forest	• Bank surfaces covered by a mixture of grasses, shrubs, blackberry, willow and introduced trees • Vegetation disruption obvious • Bare soil/closely cropped vegetation common	• Bank surfaces covered by grasses and shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to the bank
Left Bank	20 19 18 17 (16)	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right Bank	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB & RB				
Stability	• Banks stable • Erosion/bank failure absent or minimal • < 5 % of bank affected	• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5 - 30 % of bank eroded	• Moderately unstable • 30 - 60% of bank in reach has areas of erosion • High erosion potential during floods	• Unstable • Many eroded areas • 60 - 100 % of bank has erosional scars
Left Bank	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right Bank	20 19 18 (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB & RB				
4. Frequency of Riffles (run riffle rock drop pool) (diversity habitat)	• Riffles relatively frequent • Disturbance between riffles divided by width of stream = 5 - 7 • Variety of habitat is key	• Occurrence of riffles infrequer • Distance between riffles divided by width of stream = 7 - 15	• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by width of stream = 15 - 25	• Generally flat water shallow riffles • Poor habitat • Distance between riffles divided by width of stream = > 25
Score ___	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Subtotal ___		historic		current
5. Channel Alteration	• Changes to channel/dredging absent or minimal • Stream with normal pattern	• Some changes to channel dredging • Evidence of past channel dredging • Recent channel dredging not present	• Channel changes/dredging extensive • Embankments or shoring structures present on both banks • 40 - 80 % of the reach channelised and disturbed	• Banks shored with gabion or cement • > 80 % of the stream reach channelised and disturbed • Instream habitat altered or absent
Score ___	20 19 18 17 16	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1

town supply weir

QUALITATIVE HABITAT FIELD SHEET:

WADEABLE HARD BOTTOMED STREAMS

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
6. Sediment Deposition	• Little/no islands or point bars present • < 20 % of the bottom affect by stream deposition	• New increase in bar formatio mostly from gravel, sand or fine sediment • 20 - 50 % of bottom affected • Slight deposition in pools	• Some deposition of new gravel sand or fine sediment on old and new bars • 50 - 80 % of the bottom affected • Sediment deposits at obstructi constructions and bends	• Heavy deposits of fine material • Increased bar development • > 80 % of the bottom changing frequently • Pools almost absent due to sediment deposition
Score ____	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Velocity/Depth Regimes	• 4 velocity/depth regimes pre • Slow/deep, slow/shallow Fast/shallow, Fast/deep	• 3 of 4 velocity/depth regimes • If fast/shallow is missing then score lower	• 2 of 4 velocity/depth regimes • If fast/shallow or slow/shallow is missing then score lower	• Dominated by 1 velocity/ depth regime • Usually slow/deep
Score ____	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Abundance and Diversity of Habitat	• > 50 % substrate favourable for invert colonisation, wide va of woody debris, riffles, root m • Snags/submerged logs/under cut banks/cobbles provides abundant fish cover • Must not be new or transien	• 30 - 50 % substrate favourab for invertebrate colonisation • Snags/submerged logs/under-cut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material	• 10 - 30 % substrate favourabl for invertebrate colonisation • Fish cover patchy • 60 - 90 % substrate easily mo by foot • Woody debris rare or may be smothered by sediment.	• < 10 % substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or or limited to macrophytes
Score ____	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
9. Periphyton	• Periphyton not visible on har held stones • Stable substrate • Surfaces rough to touch	• Periphyton not visible on ston • Stable substrate • Periphyton obvious to touch	• Periphyton visible • < 20 % cover of available sub	• Periphyton obvious and prolific • > 20 % cover of available substrate
Score ____	20 19 18 17 16	15 (14) 13 12 11	10 9 8 7 6	5 4 3 2 1
TOTAL SCORE ____	Note: Only use means of LB and RB values			

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Field Assessment Form: Wadeable Streams

Job Number: A02277813	**Job Name:** Tui Ecology	**Assessor:** PL + AG
Location: Tui	**Date:** 15.10.15	**Time (NZST):** 1550
Site Number: SW12	**Easting:** 1840895	**Northing:** 5844094

Channel and Riparian Features

Canopy Cover		Dom Riparian Veg		Fencing	
Open		Crops		None of ineffective	X
Partly Shaded		Pasture		One side or partial	
Significantly Shaded	X	Exotic Trees		Complete both sides	
		Native Shrubs	X		

Instream Hydraulic Conditions

Ave. Stream width (active channel)		Ave Stream depth	
Max. Stream width (active channel)	2.5	Max Stream depth	
Ave. Stream width (water)	~~3~~	Ave. Surface velocity	
Max Stream width (water)	3.0		

0.8, 2.5, 2.2, 2.0, 2.0, 3.0, 3.0, 2.8

(1) 0.050, 0.085, 0.100, 0.190, 0.040

(2) 0.070, 0.130, 0.070, 0.120, 0.080, 0.100

(3) ~~F20~~ ~~0.5~~ 0.12, 0.05, 0.15

(4) 0.13, 0.08

(5) 0.080, 0.080, 0.190, 0.070, 0.060

Water Quality

Temperature (C): 10.8	Conductivity: 103.5	DO (mg/L): 8.86
		DO (%): ~~8.86~~ 101.7

pH = 6.55
ORP = 16.6

Turbidity

Clear:	X	Highly Turbid:	
Slightly Turbid:		Other:	

Stream-Bottom Substrata

Compaction (inorganic substrata):

Assorted sizes tightly packed &/or overlapping composition	
Moderately packed with some overlap	
Mostly a loose assortment with little overlap	X
No packing/loose assortment easily moved	

Embeddedness (% gravel-boulder particles covered by fine sediment):

<5%		5-25%		26-50%	X		
51-75%		>75%					

Organic Material (% cover*)

Large wood (>10cm diameter)

<5%	Y	5-25%	XX	26-50%			
51-75%		>75%					

Coarse Detritus (small wood, sticks, leaves etc)

<5%		5-25%	X	26- 50%			
51-75%		>75%					

Fine (<1mm) Organic Deposits (edges & backwaters)

<5%		5-25%	X	26-50%			
51-75%		>75%					

Habitat Types Sampled (for macroinvertebrates, % effort: each column)

(% of effort; should sum to 100%

Riffle	60	Run	40	Total%	100
Stones:		Wood			
Edges		Macrophytes		Total%	

Comments

Photo Numbers:

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QUALITATIVE HABITAT FIELD SHEET:
WADEABLE HARD BOTTOMED STREAMS

Job Name: A02777813	**PDP Job # :** A02777813	**Date:** 15.10.15	**Time (NZST)** 1550		
Location:	**Site Name:** Tui	**Assessor:** PL + AG	**Easting:**		
Site id: SW12			**Northing:**		

Habitat Parameter	Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Riparian Vegetative Zone Width	• Bankside vegetation buffer > 10 m • Continuous and dense	• Bankside vegetation buffer < 10 m • Mostly continuous	• Pathways present and /or stock access to stream • Mostly healed over	• Break frequent • Human activity obvious
Left Bank	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right Bank	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB & RB				
2. Vegetative Zone Protection	• Bank surfaces and immediate riparian zones covered by native vegetation • Trees, understory shrubs or non woody plants present • Vegetation disruption minimal	• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forest	• Bank surfaces covered by a mixture of grasses, shrubs, blackberry, willow and introduced trees • Vegetation disruption obvious • Bare soil/closely cropped vegetation common	• Bank surfaces covered by grasses and shrubs • Disruption of stream bank vegetation very high • Grass heavily grazed • Significant stock damage to the bank
Left Bank	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Right Bank	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB & RB				
Stability	• Banks stable • Erosion/bank failure absent or minimal • < 5 % of bank affected	• Moderately stable • Infrequent, small areas of erosion mostly healed over • 5 - 30 % of bank eroded	• Moderately unstable • 30 - 60% of bank in reach has areas of erosion • High erosion potential during floods	• Unstable • Many eroded areas • 60 - 100 % of bank has erosional scars
Left Bank	20 (19) 18 17 16	15 14 13 (12) 11	10 9 8 7 6	5 4 3 2 1
Right Bank	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB & RB				
4. Frequency of Riffles	• Riffles relatively frequent • Disturbance between riffles divided by width of stream = 5 - 7 • Variety of habitat is key	• Occurrence of riffles infrequer • Distance between riffles divided by width of stream = 7 - 15	• Occasional riffle or run • Bottom contours provide some habitat • Distance between riffles divided by width of stream = 15 - 25	• Generally flat water shallow riffles • Poor habitat • Distance between riffles divided by width of stream = > 25
Score ____	20 19 (18) 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Subtotal ____				
5. Channel Alteration	• Changes to channel/dredging absent or minimal • Stream with normal pattern	• Some changes to channel dredging • Evidence of past channel dredging • Recent channel dredging not present	• Channel changes/dredging extensive • Embankments or shoring structures present on both banks • 40 - 80 % of the reach channelised and disturbed	• Banks shored with gabion or cement • > 80 % of the stream reach channelised and disturbed • Instream habitat altered or absent
Score ____	(20) 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

QUALITATIVE HABITAT FIELD SHEET:
WADEABLE HARD BOTTOMED STREAMS

Habitat Parameter	Category			
	Optimal	Suboptimal	Marginal	Poor
6. Sediment Deposition	• Little/no islands or point bars present • < 20 % of the bottom affect by stream deposition	• New increase in bar formatio mostly from gravel, sand or fine sediment • 20 - 50 % of bottom affected • Slight deposition in pools	• Some deposition of new gravel sand or fine sediment on old and new bars • 50 - 80 % of the bottom affected • Sediment deposits at obstructi constructions and bends	• Heavy deposits of fine material • Increased bar development • > 80 % of the bottom changing frequently • Pools almost absent due to sediment deposition
Score ____	20 19 18 17 (16)	(15) 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Velocity/Depth Regimes	• 4 velocity/depth regimes pre • Slow/deep, slow/shallow Fast/shallow, Fast/deep	• 3 of 4 velocity/depth regimes • If fast/shallow is missing then score lower	• 2 of 4 velocity/depth regimes • If fast/shallow or slow/shallow is missing then score lower	• Dominated by 1 velocity/ depth regime • Usually slow/deep
Score ____	20 (19) 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Abundance and Diversity of Habitat	• > 50 % substrate favourable for invert colonisation, wide va of woody debris, riffles, root m • Snags/submerged logs/under cut banks/cobbles provides abundant fish cover • Must not be new or transien	• 30 - 50 % substrate favourab for invertebrate colonisation • Snags/submerged logs/under-cut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material	• 10 - 30 % substrate favourabl for invertebrate colonisation • Fish cover patchy • 60 - 90 % substrate easily mo by foot • Woody debris rare or may be smothered by sediment.	• < 10 % substrate favourable for invertebrate colonisation • Fish cover rare or absent • Substrate unstable or lacking • Stable habitats lacking or or limited to macrophytes
Score ____	20 (19) (18) (17) 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
9. Periphyton	• Periphyton not visible on har held stones • Stable substrate • Surfaces rough to touch	• Periphyton not visible on ston • Stable substrate • Periphyton obvious to touch	• Periphyton visible • < 20 % cover of available sub	• Periphyton obvious and prolific • > 20 % cover of available substrate
Score ____	20 19 18 17 16	15 14 13 12 11	10 9 (8) 7 6	5 4 3 2 1
TOTAL SCORE ____	Note: Only use means of LB and RB values			

pdp

solutions for your environment

Field Assessment Form: Wadeable Streams

Job Number: A02277813	**Job Name:** Tui Ecology	**Assessor:** AG + PL
Location: Tunakohoia	**Date:** 15/10/15	**Time (NZST):** 14:05
Site Number: SW13	**Easting:** 1839888	**Northing:** 5843614

Channel and Riparian Features

Canopy Cover		Dom Riparian Veg		Fencing	
Open		Crops @ R1		None of ineffective	X
Partly Shaded	X	Pasture ↑		One side or partial	
Significantly Shaded		Exotic Trees 15%	X	Complete both sides	
		Native Shrubs	X		

See note

Instream Hydraulic Conditions

Ave. Stream width (active channel)	2.32	Ave Stream depth	0.098
Max. Stream width (active channel)	~~1.97~~ 2.7	Max Stream depth	0.17
Ave. Stream width (water)	1.94	Ave. Surface velocity	
Max Stream width (water)	2.55		

2.3 2.7 1.87 2.4

1.95 2.55 1.75 1.6

Water Quality

Temperature (C): 11.6°C

Conductivity: 126.5

DO (mg/L): 8.93

DO (%): 102.6

pH = 6.19

ORP = -13.8

Turbidity

Clear:	X	Highly Turbid:	
Slightly Turbid:		Other:	

Stream-Bottom Substrata

Compaction (inorganic substrata):	
Assorted sizes tightly packed &/or overlapping composition	
Moderately packed with some overlap	
Mostly a loose assortment with little overlap	X
No packing/loose assortment easily moved	

Embeddedness (% gravel-boulder particles covered by fine sediment):							
<5%		5-25%		26-50%	X		
51-75%		>75%					

Organic Material (% cover*)							
Large wood (>10cm diameter)							
<5%	X	5-25%		26-50%			
51-75%		>75%					
Coarse Detritus (small wood, sticks, leaves etc)							
<5%	X	5-25%		26- 50%			
51-75%		>75%					
Fine (<1mm) Organic Deposits (edges & backwaters)							
<5%		5-25%		26-50%	X		
51-75%		>75%					

2.23 1

Habitat Types Sampled (for macroinvertebrates, % effort: each column)

(% of effort; should sum to 100%

Riffle	80	Run	20	Total%	100
Stones:		Wood			
Edges		Macrophytes		Total%	

Comments

- D/S @ R1 was shaded 10%, from R2 u/s 75-85% shaded
- Periphyton growths on rock LGF & MBM,

Photo Numbers:

metres

① 0.085 0.11 0.08 0.1 0.095

② 0.065 0.02 0.075 0.135 0.07

③ .17 .17 .08 .11 .07

④ .135 .15 .16 .06 .085

solutions for your environment

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historic

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Appendix C

Figures

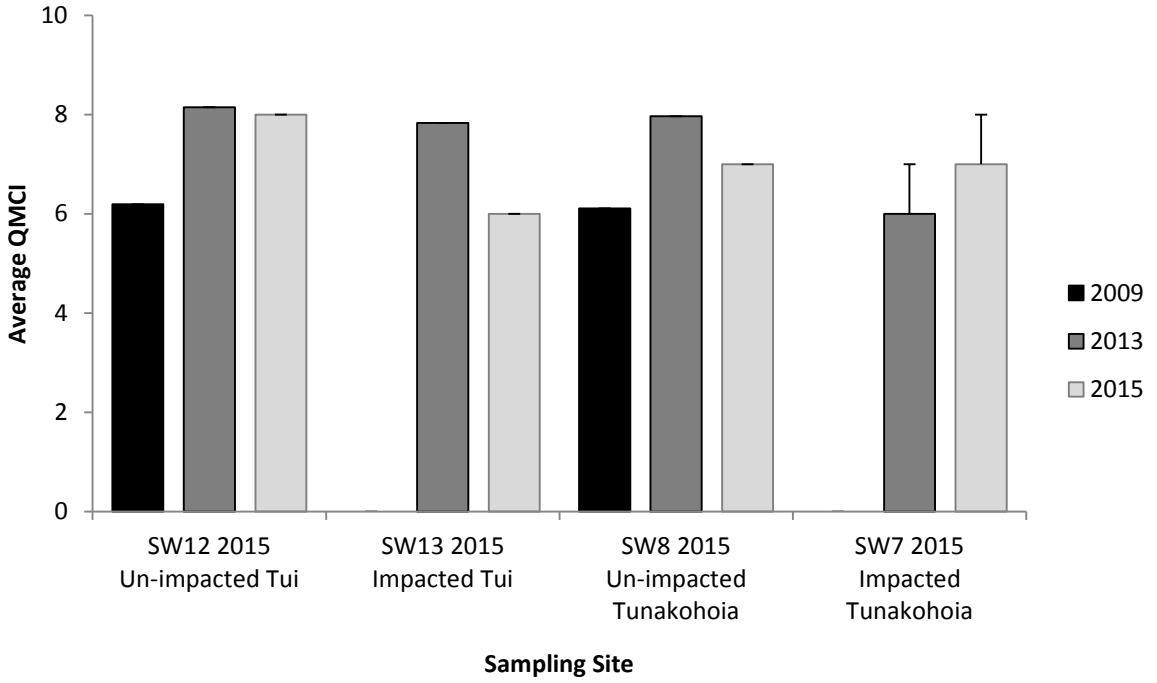

Figure 1. Average Macroinvertebrate Community Index (MCI) scores at un-impacted and impacted sites on Tui Stream and Tunakohoia Stream from 2009, 2013 and 2015. Error bars are S.E. ± (where n = 4).

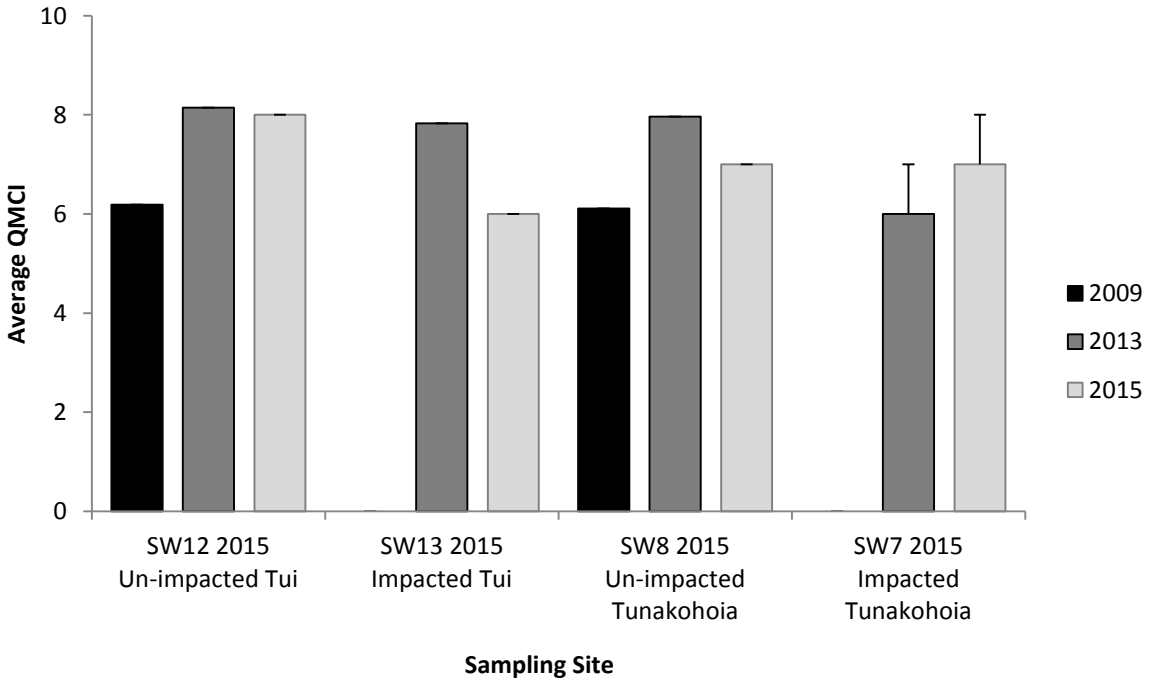

Figure 2. Average Quantitative Community Index (QMCI) scores at un-impacted and impacted sites on Tui Stream and Tunakohoia Stream from 2009, 2013 and 2015. Error bars are S.E. ± (where n = 4)

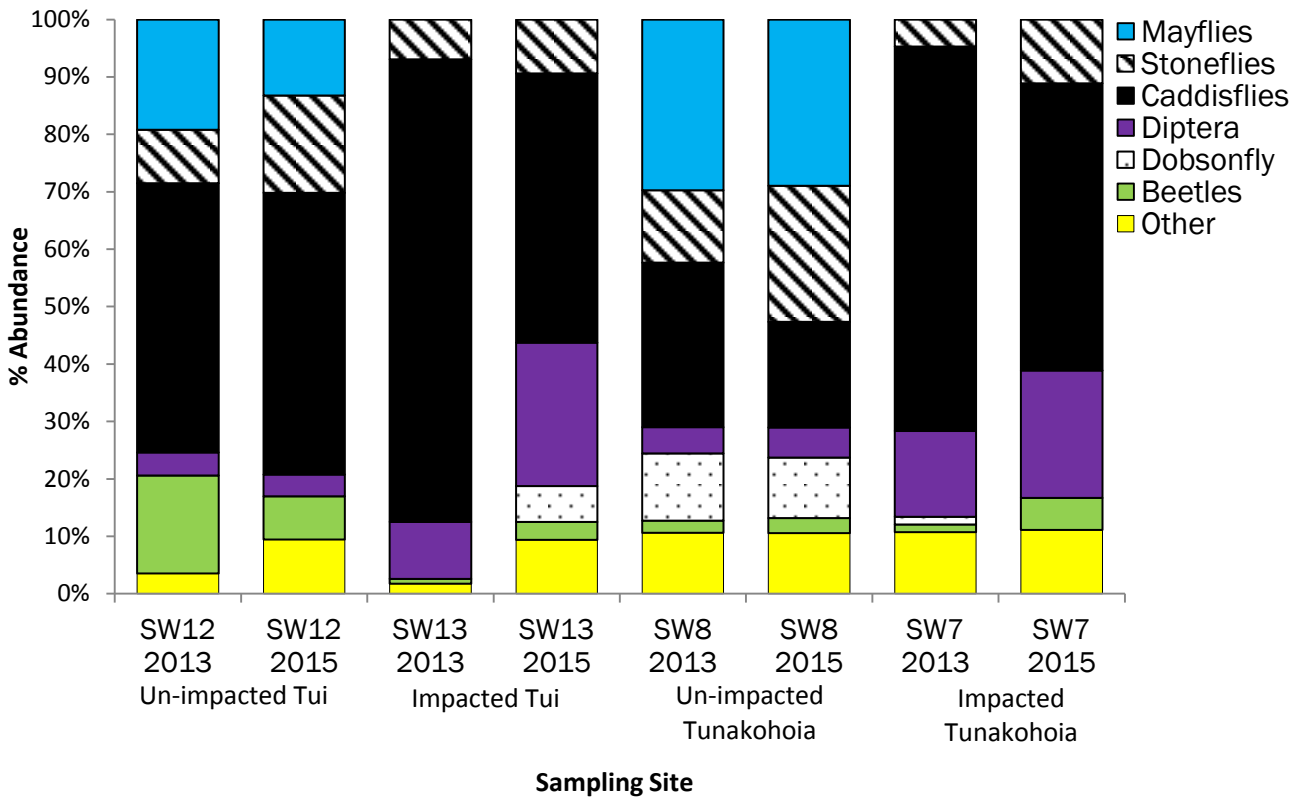

Figure 3. Macroinvertebrate community composition represented by percent abundance of dominant taxa at un-impacted and impacted sites on Tui Stream and Tunakohoia Stream. Taxa grouped as 'Other', include Crustacea, Mites, Oligochaetes and Snails.