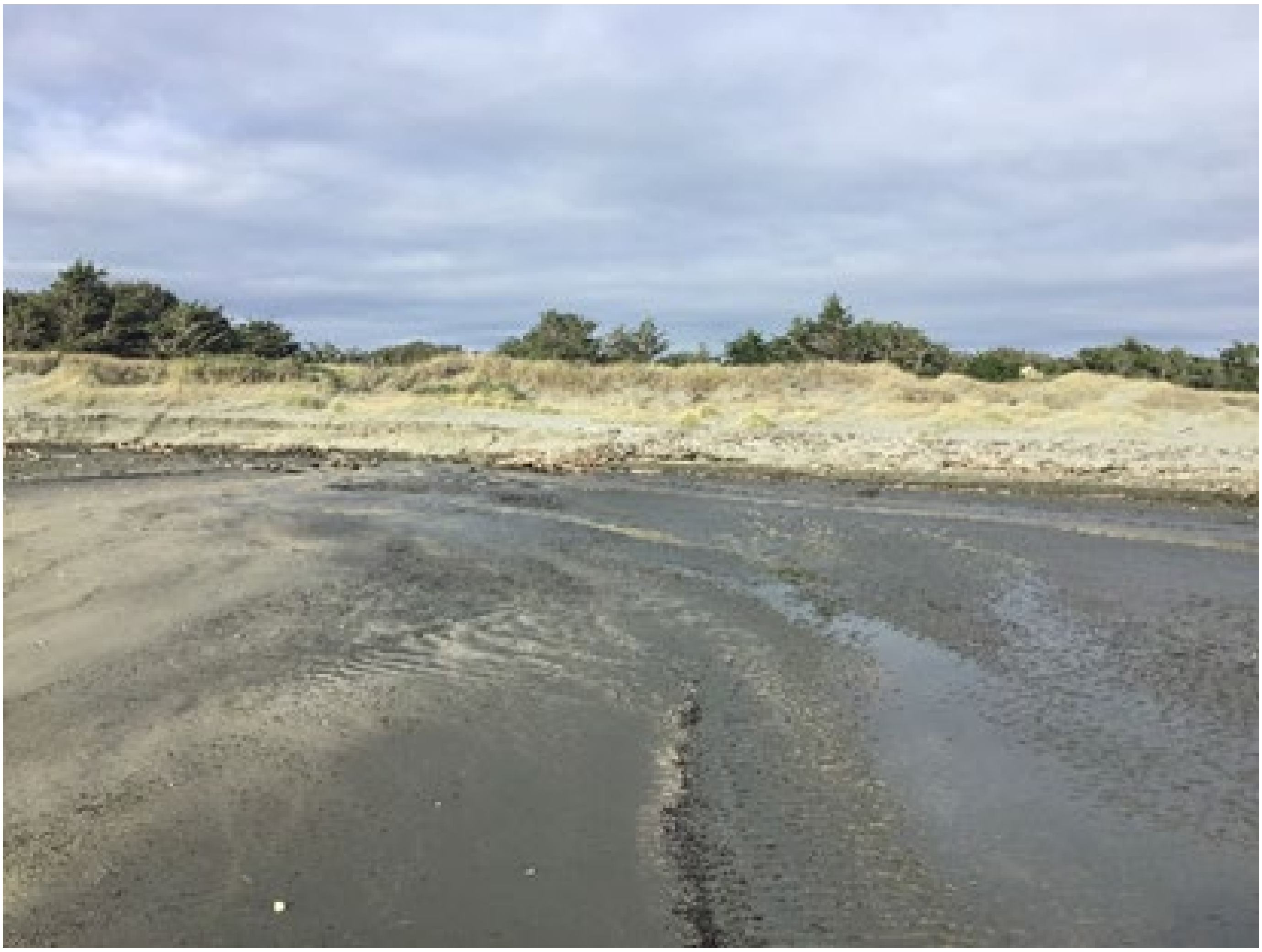
Boffa Miskell

LEVIN WASTEWATER

Assessment of Effects on Marine Ecological Values
Prepared for Horowhenua District Council

12 July 2019



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CONTENTS

Appendices

1.0 Introduction

The Levin wastewater land treatment system requires re-consenting. An understanding of the ecological values present is needed to assist in the interpretation of effects, provide guidance for the re-consenting, and provide guidance for potential wastewater land treatment upgrades and mitigation options. Boffa Miskell Ltd (BML) have been engaged to undertake an assessment of effects on marine ecology relating to the irrigation of treated wastewater to land and potential migration of wastewater through groundwater and surface water to the coast.

Horowhenua District Council (HDC) is proposing modifications to the Levin WWTP land application system. The Levin WWTP produces a secondary treated effluent which is reticulated approximately 7.1 km to a storage pond and land application system at the “Pot”. The Pot pond provides storage and infiltration which enables the optimisation of the irrigation regime independent of Levin WWTP outflows.

The Levin WWTP and the Pot are operated under existing resource consents (4960, 6610, 6624, 6920, 6921). Consent conditions include the collection of a range of monitoring data in the Waiwiri Stream (Aquanet Consulting Ltd, 2016). Additional monitoring data is also collected in the general area by HDC and other parties.

HDC purchased the neighbouring property to The Pot, known as the Tucker Block. This is a similar land area to The Pot of approximately 100 ha. The Tucker Block is currently in pasture and leased out but also provides an opportunity for additional irrigation.

This report begins (Section 2.0) by outlining the methods used to obtain information regarding the marine ecological values that are present at the coast adjacent to Waiwiri Stream mouth as well as the method for undertaking the assessment of effects. The existing values are then described for marine ecology (Section 3.0). Details are provided regarding the relevant activities (Section 4.0), and then an assessment of effects on the marine ecology associated with those activities is presented (Section 5.0). Recommendations are provided regarding measures to avoid, remedy and mitigate the potential effects of the proposal on marine ecological values (Section 6.0).

2.0 Methodology

2.1 Desktop Investigation

A desktop investigation was undertaken to obtain information regarding marine ecology along the Horowhenua coast, and specifically adjacent to the Waiwiri Stream. In addition, a literature review on the spatial and temporal variability of bivalve shellfish in open coast habitats was undertaken. The following sources were searched:

- Published literature;
- Published and unpublished reports;
- Relevant statutory documents.

2.2 Field Investigation

We did not qualitatively survey benthic invertebrate community composition, as on moderate-high energy intertidal open sandy beaches such as along the Horowhenua coast, the communities are naturally depauperate. Organisms typically detected in these habitats include three or four species of amphipod or isopod. Subtidal soft sediment communities on moderate-high energy intertidal open sandy shores are usually more diverse and abundant. However, a subtidal survey was beyond the scope of this assessment. Instead, we have relied on the shells and organism debris washed up on the intertidal shoreline to develop a likely species list.

Tuatua and sediment quality surveys were carried out on 2 July 2019 to gain a qualitative understanding of the abundance, size-frequency and quality of tuatua, and the quality of sediment at low tide.

Tuatua were searched for by hand (and foot) for 90 minutes either side of low tide[1] at sites immediately north and south of the Waiwiri Stream mouth, every 20m from the stream mouth to 200m to the north and the south, as well as reference sites between Waiwiri and Hōkio Stream and between Waiwiri and Ōhau Stream (Figure 1). Sediment was searched intensively by hand (and foot) for 5 minutes at each tuatua survey site at low tide and in the shallow subtidal habitat. At each of the tuatua survey sites, c. 30 adult tuatua were planned to be collected, measured and placed on ice. Tuatua (once shucked and composited) and sediment would then be shipped to Hill Laboratories where they would be analysed for the concentration of metals and boron[2].

Sediment samples were collected from the Waiwiri Stream mouth (north and south extent of the mouth) and reference sites 200m north and 200m south of the stream mouth and analysed for metals and boron. Contaminant concentrations were compared against the updated ANZECC sediment quality guidelines (Australian and New Zealand Governments, 2018).

2.3 Ecological Assessment

The methods used to undertake this assessment is consistent with the EIANZ guidelines for undertaking ecological impact assessments (Roper-Lindsay, Fuller, Hooson, Sanders, & Ussher, 2018), whereby ecological values are assigned (refer to Table 1) and the magnitude of effects identified effect (Table 2) in order to determine the overall level of effect of the proposal (Table 3).

[1] Low tide at Ōtaki on 2 July was approximately 3pm.

[2] Boron will be analysed as it is present in landfill leachate which is captured and treated at the Levin WWTP along with the municipal wastewater.

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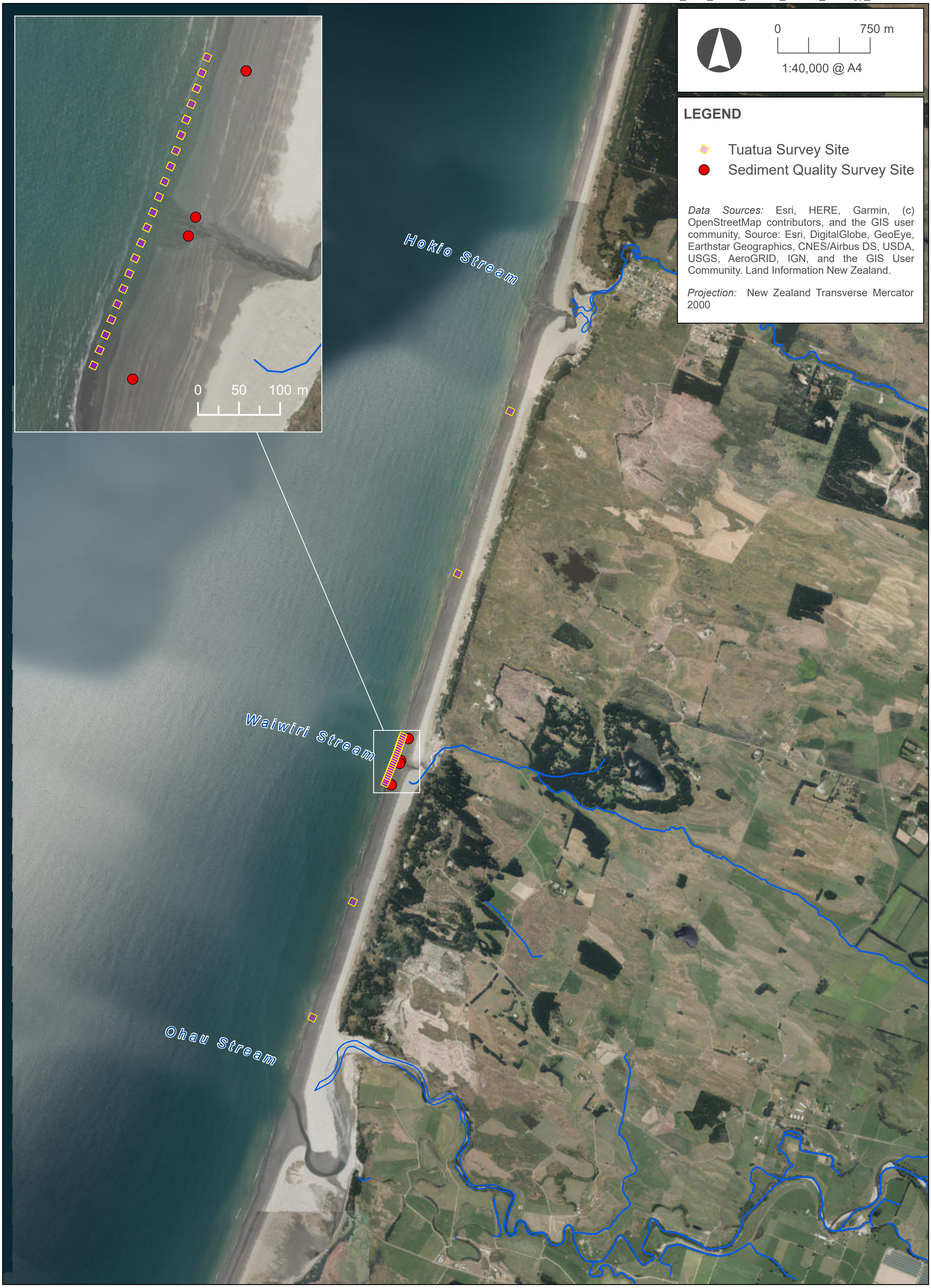

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BM19445 LEVIN WWTP MARINE ECOLOGY EFFECTS

Sediment and Tuatua Survey Sites

Date: 9 July 2019 | Revision: 0

Plan prepared for Horowhenua District Council by Boffa Miskell Limited

Project Manager: Sharon.DeLuca@boffamiskell.co.nz | Drawn: JWa | Checked: SDe

Figure 1

Table 1: Criteria for assigning ecological value to marine habitats.

ECOLOGICAL VALUE	CHARACTERISTICS
VERY LOW	• Benthic invertebrate community degraded with very low species richness, diversity and abundance. • Benthic invertebrate community dominated by tolerant organisms with no sensitive taxa present. • Marine sediments dominated by silt and clay grain sizes (>85%). • Surface sediment anoxic (lacking oxygen). • Elevated contaminant concentrations in surface sediment, above GV-high effects threshold concentrations (Australian and New Zealand Governments, 2018) . • Invasive, opportunistic and disturbance tolerant species highly dominant. • Vegetation/macroalgae absent. • Habitat extremely modified.
LOW	• Benthic invertebrate community degraded with low species richness, diversity and abundance. • Benthic invertebrate community dominated by tolerant organisms with few/no sensitive taxa present. • Marine sediments dominated by silt and clay grain sizes (>75%). • Surface sediment predominantly anoxic (lacking oxygen). • Elevated contaminant concentrations in surface sediment, above GV-high effects threshold concentrations (Australian and New Zealand Governments, 2018). • Invasive, opportunistic and disturbance tolerant species dominant. • Vegetation/macroalgae provides minimal/limited habitat for native fauna. • Habitat highly modified.
MEDIUM	• Benthic invertebrate community typically has moderate species richness, diversity and abundance. • Benthic invertebrate community has both tolerant and sensitive taxa present. • Marine sediments typically comprise less than 75% silt and clay grain sizes. • Shallow depth of oxygenated surface sediment. • Contaminant concentrations in surface sediment generally below GV-high effects threshold concentrations (Australian and New Zealand Governments, 2018). • Few invasive opportunistic and disturbance tolerant species present. • Vegetation/macroalgae provides moderate habitat for native fauna. • Habitat modification limited.
HIGH	• Benthic invertebrate community typically has high diversity, species richness and abundance. • Benthic invertebrate community contains many taxa that are sensitive. • Marine sediments typically comprise <50% smaller grain sizes. • Surface sediment oxygenated. • Contaminant concentrations in surface sediment rarely exceed DGV effects threshold concentrations (Australian and New Zealand Governments, 2018). • Invasive opportunistic and disturbance tolerant species largely absent. • Vegetation/macroalgae provides significant habitat for native fauna. • Habitat largely unmodified.
VERY HIGH	• Benthic invertebrate community typically has very high diversity, species richness and abundance. • Benthic invertebrate community contains dominated taxa that are sensitive. • Marine sediments typically comprise <25% smaller grain sizes.

ECOLOGICAL VALUE	CHARACTERISTICS
	• Surface sediment oxygenated with no anoxic sediment present. • Contaminant concentrations in surface sediment significantly below DGV effects threshold concentrations (Australian and New Zealand Governments, 2018). • Invasive opportunistic and disturbance tolerant species absent. • Vegetation/macroalgae sequences intact and provides significant habitat for native fauna. • Habitat unmodified.

Table 2: Criteria for describing magnitude of effect (Roper-Lindsay et al., 2018)

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

Table 3: Criteria for describing the level of effect (Roper-Lindsay et al., 2018)

LEVEL OF EFFECT		ECOLOGICAL AND / OR CONSERVATION VALUE				
		Very High	**High**	**Moderate**	**Low**	**Negligible**
MAGNITUDE	**Very High**	Very High	Very High	High	Moderate	Low
	High	Very High	Very High	Moderate	Low	Very Low
	Moderate	High	High	Moderate	Low	Very Low
	Low	Moderate	Low	Low	Very Low	Very Low
	Negligible	Low	Very Low	Very Low	Very Low	Very Low
	Positive	Net gain	Net gain	Net gain	Net gain	Net gain

3.0 Marine Ecological Values

3.1 Desktop Investigation

3.1.1 Existing External Literature / Reports / Data

The marine environment that Waiwiri Stream discharges to is a moderate-high energy exposed beach. There is limited existing information on the marine ecological values of beaches on the Horowhenua coast, including the Waiwiri Stream mouth.

Waiwiri Stream flows out of a shallow dune lake (Papaitonga) and meanders through pastoral landuse to the south of The Pot, ultimately discharging to the west coast between Hōkio Stream to the north and the Ōhau River to the south. The water quality of Waiwiri Stream is characterised by having elevated nutrients and faecal coliform concentrations, which is similar to other waterways along the Horowhenua coast. Observations by shellfish survey teams in 2014 included noting a freshwater seepage of water through the sand at 20-200m down the shore at a site south of Waiwiri Stream. Freshwater seepages are common along the Horowhenua coast (e.g. south of Hōkio, north of Ōhau, north of Waikawa) (Newcombe, Poutama, et al., 2014).

Coastal water quality is monitored along the Horowhenua coast in summer months, in terms of recreational contact, by Horizons Regional Council (HRC) and Greater Wellington Regional Council (GWRC). Data collected by both councils indicated good water quality (Roygard et al., 2013) (Morar & Greenfield, 2013).

Sediment grain size north and south of the Waiwiri Stream is dominated by fine sand (c.80%), with an organic matter content of approximately 0.8%-1.2%. Nitrogen content of sand at sites north and south of Waiwiri Stream mouth was below detection limit of 0.02 mg/100 g (Newcombe, Poutama, et al., 2014).

There is minimal information about the benthic marine ecological values along the Horowhenua coast. However, being a moderate-high energy surf beach with sand being the dominant sediment grain size, it is likely that the diversity of benthic invertebrate taxa is naturally relatively low. Mid-low intertidal sediments are likely to contain several amphipod and isopod species as well as a low diversity of bivalves. Some bivalve species are also likely to be present in the shallow subtidal habitat, along with other organisms such as crabs and gastropods.

Tuatua (*Paphies subtriangulata* and *Paphies donacina*) have been shown to be present within the sub-littoral habitat along the Horowhenua coast (including north and south of Waiwiri Stream mouth and were the most abundant shellfish adjacent to Waiwiri Stream. Other shellfish detected along the Horowhenua coast included toheroa (*Paphies ventricosa*) and trough shells (*Crassula aequilatera*) and *Dosinia* sp. (Newcombe, Poutama, et al., 2014).

North of the Waiwiri Stream, 3-6 cm length tuatua are present low on the intertidal shore at approximately 40 individuals per m^2. South of Waiwiri Stream, abundance of tuatua was highest at mid-shore level, with approximately 20 organisms per m^2 (3-6 cm length). A weak pattern of lower abundance of tuatua close to public access points was noted, which may indicate harvesting pressure (Newcombe, Smith, et al., 2014).

Toheroa have significantly declined at a number of locations around New Zealand, including the Horowhenua coast (Newcombe, Poutama, et al., 2014), and despite being protected for 40 years, populations have failed to recover (Ross et al., 2018). A number of hypotheses have been put forward regarding the lack of recovery, including over-harvesting, changes in landuse, changes to hydrology, operation of vehicles on beaches, toxic algal blooms, and changes in climate and weather (J. R. Williams, Sim-Smith, & Paterson, 2013). Toheroa are commonly found in association with freshwater seepages in the mid-tidal height (Newcombe, Poutama, et al., 2014). In a survey carried out in 2014, two toheroa were detected adjacent to the Waiwiri Stream (Newcombe, Poutama, et al., 2014).

A survey of faecal contamination of tuatua at three locations adjacent to the mouth of the Waiwiri Stream was undertaken in 2012 (Allen, Sinner, Banks, & Doehring, 2012). Results of microbial source tracking analyse indicated that the faecal contamination present in the shellfish was related to ruminant animals (commonly cattle or sheep), with no indicators of human effluent. A survey of faecal coliforms in shellfish collected at Otaki and six other marine shellfish gathering sites in GWRC revealed that 25% of the samples from Otaki had faecal coliforms above contact recreation guideline criteria in 2012/2013 (Morar & Greenfield, 2013). A survey of faecal contamination of shellfish along the Horowhenua coast was also undertaken in 2014 (Newcombe, Smith, et al., 2014), including sites immediately north and south of Waiwiri Stream mouth. Data indicated elevated indicator bacteria concentrations were present in tuatua after rainfall at levels described as 'marginally acceptable' and 'unacceptable' for human consumption by the New Zealand Ministry of Health (Ministry of Health, 1995).

Concerns have been raised by tangata whenua regarding the effect on abundance and quality of kaimoana related to treated wastewater seepages to the coast and discharge via surface water to the coast. The primary harvestable shellfish at the Waiwiri Stream mouth are historically toheroa and currently tuatua. Toheroa have declined in abundance at a number of sites around New Zealand, with the cause being unidentified. Abundance of tuatua is known to be spatially and temporally variable due to a range of factors (see Appendix A).

The existing literature suggests that there is generally good coastal water quality and high dilution afforded by the coastal environment. Where there has been found shellfish contamination indicator bacteria source tracing does not indicate the presence of human wastewater as the source. It is unlikely that treated wastewater that finds it way to the coast is responsible for a decline in shellfish abundance. However, a survey of the body burden of wastewater contaminants in tuatua flesh may be appropriate.

3.1.2 Existing Project-related Reports and Data

The application of wastewater to land and storage of wastewater at the Pot pond have resulted in localised mounding of groundwater. Surveys of groundwater indicate low levels of metals are present (below human drinking standards[3]), in addition to nutrients (ammonia, nitrate nitrogen and phosphorus).

Surface drains provide a mechanism for intercepting shallow groundwater impacted by wastewater, which ultimately flows to the Waiwiri Stream and then to the coast. It is estimated that a high proportion (approximately 80%) of shallow groundwater is captured by surface water system, with the remaining 20% likely to seep out directly onto the beach, bypassing Waiwiri Stream (Stephen Douglass, pers. comm. 26 July 2019).

Surface water monitoring by Aquanet Consulting (2015) indicated increased nitrate-nitrogen, soluble inorganic nitrogen and total nitrogen, and to a lesser extent phosphorus, concentrations in Waiwiri Stream between upstream and downstream of the Pot. The concentration of metals

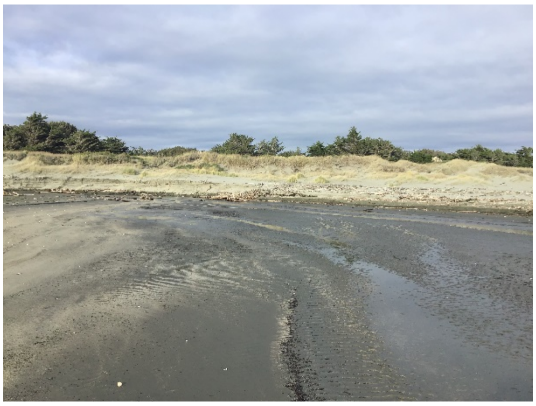
[3] Page 18, Discharge Description and Assessment of the Effects to Land, 20187. Report prepared for Horowhenua District Council, Lowe Environmental Impact.

in the main drain running through the irrigation area were below ANZECC 95% species protection levels and concentrations in sediment from the Waiwiri Stream upstream, adjacent to, and downstream of the Pot irrigation area were also below ANZECC ISQG-Low trigger levels.

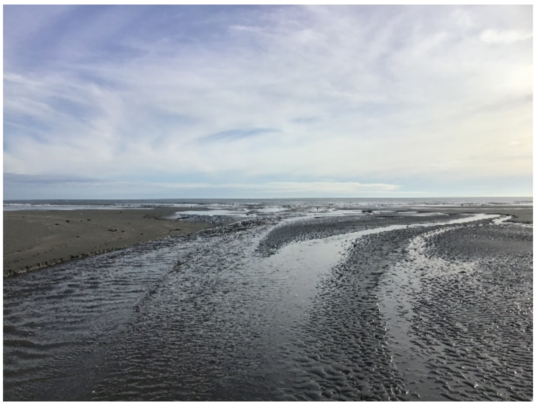
Water quality samples collected by Aquanet Consulting in 2015 at sites to the north and south of the Waiwiri Stream mouth, although limited, generally indicated low concentrations of nutrients in the coastal waters (mostly below detection limits), with no significant differences observed between any of the sites, including a reference site approximately 1.6 km further north along the coast (Aquanet, 2015).

3.2 Field Investigation

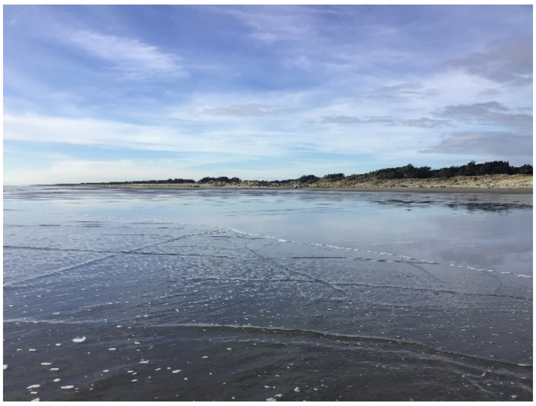
The Waiwiri Stream mouth, intertidal habitat and Horowhenua coastline are shown in Photographs 1-4 below.



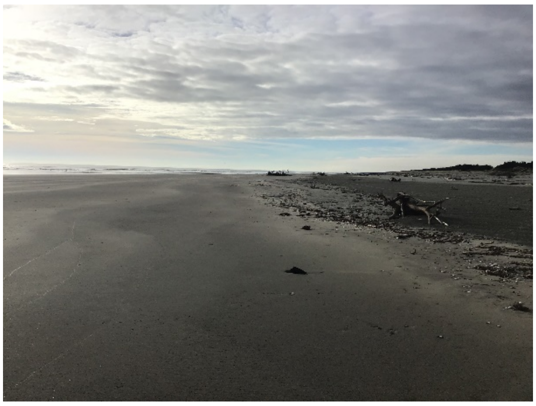
Photograph 1: Waiwiri Stream mouth



Photograph 2: Waiwiri Stream mouth



Photograph 3: Intertidal habitat adjacent to Waiwiri Stream mouth



Photograph 4: The extensive Horowhenua coastal habitat (looking north)

The search for tuatua at low tide revealed extremely low numbers (n=3), with only one adult found in the survey (64mm shell length) and two juveniles (33 mm and 19mm shell length). This is substantially less than (Newcombe, Poutama, et al., 2014) found in their surveys. There were fresh tuatua shells on the beach that had been likely been discarded by birds, but a population of tuatua was not detected at any of the sites in our survey. Given the presence of fresh shells on the shore, it is likely that tuatua are present in the area, but in low densities in the low intertidal and shallow subtidal habitat.

A range of other benthic species were detected in the low intertidal/shallow subtidal habitat during the tuatua survey, or evidence of their presence in the subtidal habitat was indicated by shells washed up on shore and are detailed in Table 4. A moderate diversity of bivalves and gastropods are likely to be present in the subtidal zone along the coast.

Table 4: Species present on Horowhenua coast within the vicinity of Waiwiri Stream

Common name	Maori name	Scientific name	Habitat
Paddle crab	Papaka	*Ovalipes catharus*	Shallow subtidal
Knobbed whelk	Kākara	*Austrofusus glans*	Shallow subtidal to 600m depth
Large ostrich foot	Kaikai-karoro, takai, totorere	*Struthiolaria papulosa*	30-200m subtidal
Turret shell	Kukukuoaroa	*Maoricolpus roseus roseus*	Low intertidal to 130m depth
Surf clam	-	*Mactra* spp.	Subtidal to 10m depth
Triangular trough shell	Kaikaikaroro	*Crassula aequilatera*	Low intertidal to 10m depth
Surf clam	Tuatua	*Paphies subtriangulata*	Low mid-intertidal to shallow subtidal
Surf clam	-	*Dosinia* spp.	Low intertidal to 10m depth
Scallop	Kuakua	*Pecten novaezelandize*	Shallow subtidal to 60m depth
Horse mussel	Kūkukuroa	*Atrina zealandica*	Shallow subtidal to 60m depth
Razor mussel	-	*Solemya parkinsonii*	Low intertidal to 60m depth
Ribbed venus clam	Karoro	*Protothaca crassicosta*	Mid-low intertidal to shallow subtidal
Sand dollar	Kina papa	*Fellaster zelandiae*	Low intertidal, shallow subtidal

Species of birds, in relatively large groups (c.20-40), that were observed utilising the intertidal and upper shore for foraging and roosting during the tuatua survey, included Southern black backed gull (*Larus dominicanus*), red billed gulls (*Larus novaehollandiae*), variable oyster catcher (*Haematopus unicolor*), pied stilt (*Himantopus himantopus*) and common tern (*Sterna hirundo*).

Sediment contaminant analyses at Waiwiri Stream mouth and the reference sites (200m either side of the stream mouth) indicated very low concentrations at all four sites. Contaminants at all sites were significantly below the Default Guideline Value (DGV) (Australian and New Zealand Governments, 2018), which corresponds to the previous Interim Sediment Quality Guidelines (Low) (Table 5).

Table 5: Concentration of contaminants in sediment at four sites surveyed

Contaminant concentration mg/kg ww	Waiwiri Stream mouth North	Waiwiri Stream mouth South	200m North of Waiwiri Stream mouth	200m South of Waiwiri Stream mouth	ANZECC (2018) DGV
Arsenic	3.2	3.2	3.2	3.1	20
Cadmium	0.005*	0.005*	0.005*	0.005*	1.5
Chromium	7.6	7.4	6.3	6.6	80
Copper	2.7	2.7	3.1	2.9	65
Lead	3.1	3.2	3.3	3.1	50
Nickel	7.1	6.8	6.0	6.4	21
Zinc	28	28	26	26	200
Boron	4	5	5	6	N/A

- = half the laboratory detection limit

Contaminants were not present at significantly higher concentrations at the Waiwiri Stream mouth sites compared to the reference sites (Table 6).

Table 6: Proportion of Default Guideline Value at Waiwiri Stream and Reference Sites

Contaminant	Average Proportion of DGV at Waiwiri Stream mouth (n=2)	Average Proportion of DGV at reference sites (n=2)
Arsenic	16.0	15.8
Cadmium	3.3	3.3
Chromium	9.4	8.0
Copper	4.2	4.6
Lead	6.3	6.4
Nickel	33.1	29.5
Zinc	14.0	13.0
Boron	N/A	N/A

Sediment quality did not indicate any contamination that would inhibit shellfish larvae settlement or recruitment.

3.3 Summary of Marine Ecological Values

Horizon Regional Council's One Plan (Schedule F) identifies habitats that are rare, threatened or at risk. Other than adjacent duneland habitats, no marine habitats are identified in the plan as being significant in terms of biological diversity. In addition, criteria for assessing ecological significance are provided Policy 13-5 of the One Plan. The benthic marine environment adjacent to Waiwiri Stream is also not a habitat identified in Schedule F and does not meet the significance criteria in Policy 13-5.

The benthic marine invertebrate taxa and assemblages that have been identified adjacent to the Waiwiri Stream mouth in low intertidal and shallow subtidal habitats are common species, with no *Threatened* or *At Risk* species present. We note that there has been a documented decline in toheroa along the Horowhenua coast, and that tuatua, which were able to be sampled in 2014 at 12 sites between Ōtaki and Hōkio, were not detected any abundance in our survey between Hōkio and Ōhau.

Sediment quality was high, with sites and Waiwiri Stream and reference sites having low concentrations of metals.

It is unlikely that the discharge of treated wastewater to the coast via the Waiwiri Stream and via groundwater seepages onto the beach is the cause of the decline in toheroa and tuatua along the Horowhenua coast (see Appendix 1). The presence of *Paphies* spp. (pipi, tuatua and toheroa) are known to be highly variable in space and time (Marsden, 2002). The decline of tuatua along the coast is likely due to movement of tuatua beds, a cohort of shellfish reaching the end of their natural life span, and lack of recruitment of juveniles in that particular area. Habitat parameters appear to be suitable for recruitment, but recruitment success depends on a number of factors, including local hydrodynamic conditions, currents and long-shore drift and substrate. Toheroa have declined at a number of locations around New Zealand and are known to be affected by vehicles driving along the mid shore habitat at low tide. Vehicles may have contributed to the decline along the Horowhenua coast.

With reference to Table 1, the ecological criteria that could be assessed at the Waiwiri Stream mouth include the following:

- Marine sediments likely to comprise <25% smaller grain sizes (being a sandy beach)[4].
- Contaminant concentrations do not exceed DGV.
- No invasive or opportunistic species were detected as present[5]
- Habitat relatively unmodified[6].

The ecological value of the marine habitat is considered high-very high, based on high water and sediment quality, sand grain sizes, low level of modification, and likely presence of typical benthic invertebrate assemblages for the type of habitat.

[4] Sediment grain size was not quantitatively surveyed, but is clearly sand grain sizes, with previous reports estimating fine sand to form approximately 80% of the sediment profile.

[5] A quantitative benthic invertebrate community composition survey was not carried out.

[6] We observed vehicles, people and dogs along the beach.

4.0 Description of Activities

The consent application relates to the discharge of treated wastewater from Levin. The discharge includes activities that occur at the Pot storage pond and the irrigation to forestry. We understand that wastewater seeps out of the Pot pond to groundwater, and that approximately 80% of the wastewater seepages end up in surface water, and ultimately discharged to the coast via the Waiwiri Stream.

The proposed activities to expand/upgrade the wastewater treatment and discharge facility described below are unlikely to change the existing situation where treated wastewater ultimately discharges to the coast. We have assumed that best practice erosion and sediment controls will be put in place during earthworks and therefore the discharge of sediment-laden water to surface water and then the coast will be avoided or minimised. Therefore, this report primarily focuses on assessment of the effect of the discharge of wastewater to the marine environment on marine ecological values.

5.0 Assessment of Effects

5.1 Discharge of wastewater to the marine environment

The application of treated wastewater to land and storage of wastewater at the Pot pond has resulted in and will likely continue to result in the treated wastewater through surface and ground water ultimately to the coastal environment. The proposed activities which will likely involve increased seepages from all parts of the upgraded irrigation area, temporarily divert groundwater, and discharges to groundwater are unlikely to have a significant effect on marine ecological values. This is on the basis that the secondary treatment of the water remains as good as it has been, or is improved upon as proposed, and on the marine receiving environment which is a moderate-high energy sandy beach that provides significant dilution and dispersion of discharges to the coast from streams and seepages, and that there is no evidence of adverse effects from the current discharge of treated wastewater.

The magnitude of effect of the discharge of treated wastewater on marine ecological values (historic and as proposed) is assessed as negligible (Table 2). In combination with High to Very High ecological values, the overall level of effect is Low to Very Low (Table 3).

5.2 Earthworks

We understand the scale of earthworks is very small, involving some trenching for new mainlines. Earthworks are located a sufficient distance away from any surface water and are not expected to discharge sediment-laden water.

The magnitude of effect of the discharge of sediment-laden water from erosion and sediment control devices is assessed as negligible (Table 2). In combination with High to Very High ecological values, the overall level of effect is Low to Very Low (Table 3).

5.3 Summary of Potential Effects

The potential level of adverse effects of the proposed activities on marine ecological values is Low to Very Low (Table 7).

Table 7: Summary of Effects on Marine Ecological Values

ACTIVITY	ECOLOGICAL VALUE	MAGNITUDE OF EFFECT	LEVEL OF EFFECT
Discharge of wastewater to the marine environment	High/Very High	Negligible	Low/Very Low
Discharge of sediment-laden-water from earthworks	High/Very High	Negligible	Low/Very Low

6.0 Recommendations to Avoid, Remedy and Mitigate Effects on Marine Ecological Values

Mitigation for effects on marine ecological values is not required, as the level of effects are Low to Very Low.

However, the Project Team propose the following mitigation measures to be implemented within 5-30 years include:

- Upgrade of the irrigation system
- Harvesting of pines and replanting some areas with native trees
- Denitrification walls
- Catchment management
- Identifying additional land areas for irrigation
- Ecosystem trials (planting manuka and kanuka to inhibit nitrification and kill bacteria)
- Riparian planting
- Wetland establishment to filter suspended material and nutrients

Many of these measures will reduce the mass of contaminants discharging to the receiving environment. Other mitigation measures will result in ecosystem enhancement in the Waiwiri catchment and Waiwiri Stream[7].

[7] Appendix G, AEE.

7.0 References

Allen, C., Sinner, J., Banks, J., & Doehring, K. (2012). *Waiwiri Stream: Sources of poor water quality and impacts on the coastal environment* (Cawthron Report No. 2240). Nelson: Cawthron Report prepared for Horizons Regional Council.

ANZECC. (2000). Australian and New Zealand guidelines for fresh and marine water quality. *Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra*, 1–103.

Aquanet Consulting Ltd. (2016). *Levin WWTP land application at "The Pot": Water quality and ecology of the Waiwiri Stream, 2013-2016.* (Report Prepared for Horowhenua District Council No. B6b:2016). Palmerston North.

Australian and New Zealand Governments. (2018). Australian and New Zealand guidelines for fresh and marine water quality. Retrieved from www.waterquality.gov.au/anz-guidelines

Defeo, O., & McLachlan, A. (2005). Patterns, processes and regulatory mechanisms in sandy beach macrofauna: A multi-scale analysis. *Marine Ecology Progress Series*, *295*, 1–20.

Gadomski, K., & Lamare, M. (2015). Spatial variation in reproduction in southern populations of the New Zealand bivalve *Paphies ventricosa* (Veneroida: Mesodesmatidae). *Invertebrate Reproduction & Development*, *59*(2), 81–95.

Hannan, D. A., Constable, H. B., Silva, C. N. S., Bell, J. J., Ritchie, P. A., & Gardner, J. P. A. (2016). *Genetic connectivity amongst New Zealand's open sandy shore and estuarine coastal taxa* (New Zealand Aquatic Environment and Biodiversity Report No. 172). Wellington: Ministry for Primary Industries.

Hedgecock, D., & Pudovkin, A. I. (2011). Sweepstakes reproductive success in highly fecund marine fish and shellfish: A review and commentary. *Bulletin of Marine Science*, *87*(4).

Marsden, I. D. (2002). Recruitment in the swash zone – temporal variations in juvenile recruitment of an exposed sand beach surf clam. *Hydrobiologia*, *477*(1–3), 47–57.

Ministry of Health. (1995). *Microbiological reference criteria for food*. Wellington: Ministry of Health.

Morar, S., & Greenfield, S. (2013). *On the Beaches 2012/13: Annual recreational water quality monitoring report for the Wellington Region* (Greater Wellington Publication No. GW/ESCI-G-13/64). Greater Wellington Regional Council.

Newcombe, E., Poutama, M., Allen, C., Smith, H., Clark, D., Atalah, J., … Sinner, J. (2014). *Kaimoana on beaches from Hokio to Otaki, Horowhenua* (Cawthron Report No. 2564). Nelson: Prepared by Cawthron Institute for Taiao Raukawa and Manaaki Taha Moana.

Newcombe, E., Smith, H., Poutama, M., Clark, D., Spinks, A., Ellis, J., & Sinner, J. (2014). *Faecal contamination of shellfish on the Horowhenua coast* (Cawthron Report No. 2573). Cawthron Institute for Taiao Raukawa and Manaaki Taha Moana.

Roper-Lindsay, J., Fuller, S. A., Hooson, S., Sanders, M. D., & Ussher, G. T. (2018). *Ecological impact assessment (EcIA). EIANZ guidelines for use in New Zealand: Terrestrial and freshwater ecosystems* (2nd ed.). Melbourne: EIANZ.

Ross, P. M., Knox, M. A., Smith, S., Smith, H., Williams, J., & Hogg, I. D. (2018). Historical translocations by Maori may explain the distribution and genetic structure of a threatened surf clam in Aotearoa (New Zealand). *Nature / Scientific Reports*, *8*.

Roygard, J., Koehler, A., Mercer, R., Clark, M., Brown, L., Patterson, M., … Bell, J. (2013). *Horizons Regional Council 2013 State of the Environment Report* [Horizons Report].

Williams, J., Ferguson, H., & Tuck, I. (2013). *Distribution and abundance of toheroa (*Paphies ventricosa*) and tuatua (*P. subtriangulata*) at Ninety Mile Beach in 2010 and Dargaville Beach in 2011* (New Zealand Fisheries Assessment Report No. 2013/39). Wellington: Ministry for Primary Industries.

Williams, J. R., Sim-Smith, C., & Paterson, C. (2013). *Review of factors affecting the abundance of toheroa (*Paphies ventricosa*)* (New Zealand Aquatic Environment and Biodiversity Report No. 114). Wellington: Ministry for Primary Industries.

Appendix 1: Summary of Literature - Temporal and Spatial Variability in Shellfish (*Paphies* spp.) Populations

Sandy beach habitats are dynamic due to interactions between tides, waves and sand/sediment. Benthic communities on sandy beaches are typically dominated by molluscs, crustaceans and polychaete worms, but communities and populations are very dynamic in space and time (Marsden, 2002). Due to the harsh environmental forces on sandy beaches, organisms may direct energy to maintenance, with less energy directed to reproduction and resultant higher mortality (Defeo & McLachlan, 2005). In addition, the harsh nature of sandy beaches can affect settlement and recruitment processes.

Reproductive cycles in surf clams in New Zealand (including *Paphies*[8] spp.) is influenced by temperature, localised upwelling of nutrients, changes in salinity and runoff. There are typically large fluctuations in the abundance of species that have a planktonic stage, with high variability in recruitment and populations being dominated by a single age class (Hannan et al., 2016). Large variation in reproductive success results in temporal and spatial variation in recruiting larvae, which effects the temporal and spatial variation of the population.

There are often considerable along-shore and across-shore variation in benthic invertebrate populations (including *Paphies* spp.) on sandy beaches, due to differences in exposure, sand particle size, swash characteristics, morphodynamics, salinity, localised food concentrations, harvesting, interspecific competition for space and human interventions such as installation of structures and movement of vehicles (Defeo & McLachlan, 2005). Larval, juvenile and adult tuatua are known to be mobile, which influences spatial heterogeneity (Marsden, 2002).

Temporal and spatial variation in abundance of *Paphies* species occurs in New Zealand. There are four species within the *Paphies* genus in New Zealand; *P. australis* (pipi), *P. subtriangulata* and *P. donacina* (tuatua), and *P. ventricosa* (toheroa). Whilst annual reproductive cycles are typical for the *Paphies* genus, within and between sites there can be reproductive differences and therefore recruitment differences (Gadomski & Lamare, 2015). Being broadcast spawners, with external fertilisation and a planktonic larval stage of 2-3 weeks, and often inhabiting high-moderately exposed environments, there is potential for larval dispersal beyond the site of origin. Reproductive success in broadcast spawners has been referred to as 'sweepstakes-like' chance of matching reproductive activity with hydrodynamic conditions conducive to maturation of gametes, fertilisation, larval development, larval settlement and recruitment to the adult population (Hedgecock & Pudovkin, 2011). *Paphies* larvae settle high on the intertidal shore and progressively move down shore as they grow and mature, with adult pipi and tuatua occupying low intertidal and shallow subtidal habitats (J. Williams, Ferguson, & Tuck, 2013) and adult toheroa occupying the intertidal mid-shore habitat.

[8] Paphies are bivalve molluscs, belong to the Mesodesmatidae family, comprising large edible surf clams (pipi, tuatua and toheroa).

Appendix 2: Hill Laboratory Data

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Certificate of Analysis

Client:	Boffa Miskell Limited	**Lab No:**	2202650 SPv1
Contact:	S De Luca	**Date Received:**	03-Jul-2019
	C/- Boffa Miskell Limited	**Date Reported:**	08-Jul-2019
	PO Box 13373	**Quote No:**	99612
	Tauranga 3141	**Order No:**	BM19445
		Client Reference:	BM19445
		Submitted By:	S De Luca

Sample Type: Sediment

Sample Name:		N Waiwiri 02-Jul-2019	S Waiwiri 02-Jul-2019	200m N Waiwiri 02-Jul-2019	200m S Waiwiri 02-Jul-2019	
Lab Number:		2202650.1	2202650.2	2202650.3	2202650.4	
Individual Tests						
Total Recoverable Boron	mg/kg dry wt	4	5	5	6	-
Heavy metal, trace level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	3.2	3.2	3.2	3.1	-
Total Recoverable Cadmium	mg/kg dry wt	< 0.010	< 0.010	< 0.010	< 0.010	-
Total Recoverable Chromium	mg/kg dry wt	7.6	7.4	6.3	6.6	-
Total Recoverable Copper	mg/kg dry wt	2.7	2.7	3.1	2.9	-
Total Recoverable Lead	mg/kg dry wt	3.1	3.2	3.3	3.1	-
Total Recoverable Nickel	mg/kg dry wt	7.1	6.8	6.0	6.4	-
Total Recoverable Zinc	mg/kg dry wt	28	28	26	26	-

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.
Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

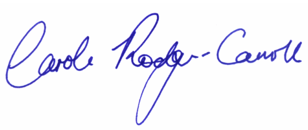
Sample Type: Sediment

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-4
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-4
Heavy metal, trace level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, trace level.	0.010 - 0.4 mg/kg dry wt	1-4
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-4
Total Recoverable Boron	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	2 mg/kg dry wt	1-4

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

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

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



Carole Rodgers-Carroll BA, NZCS
Client Services Manager - Environmental

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This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

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