Whangamata Wastewater Disposal System Upgrade

Survey of an un-named tributary of the Waikiekie Stream and surrounding area

March 2008



Kessels & Associates Ltd
ECOLOGY AND ENVIRONMENTAL PLANNING

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1 Introduction

1.1 Ecological Survey and Assessment

As part of the Whangamata Wastewater Disposal System upgrade additional storage is required in the Tairua Forest near the existing storage pond. The area is already highly modified as a result of the original works required to build the existing pond, and access tracks to the pond. The additional storage and associated works near the retention pond in Whangamata will require stream diversion along the southern face of the retention pond to be diverted around the extended pond.

There are two options being considered for the stream diversion route. The first and preferred is to move the existing diversion to run along the new southern face of the pond and continue to feed into the wetland area (eastern route), the second route is to divert the stream along the western face of the existing pond (behind the pump station and hut) to flow directly into the Waikiekie Stream (western route). Either option will require resource consent to permanently divert the tributary. In addition to the stream diversion, there will be a significant amount of earthworks and working in or near waterways required to both raise the existing pond embankments and extend the pond which will also require consents.

This report presents preliminary results and recommendations of a biological survey for the proposed Whangamata storage pond upgrade carried out on the 5th and 6th of March 2008. Vegetation assessment was carried out both downstream of the wetland and in surrounding stream vegetation. Water quality, invertebrate and fish surveys were undertaken in order to obtain a full picture of the fishery state and value of the stream.

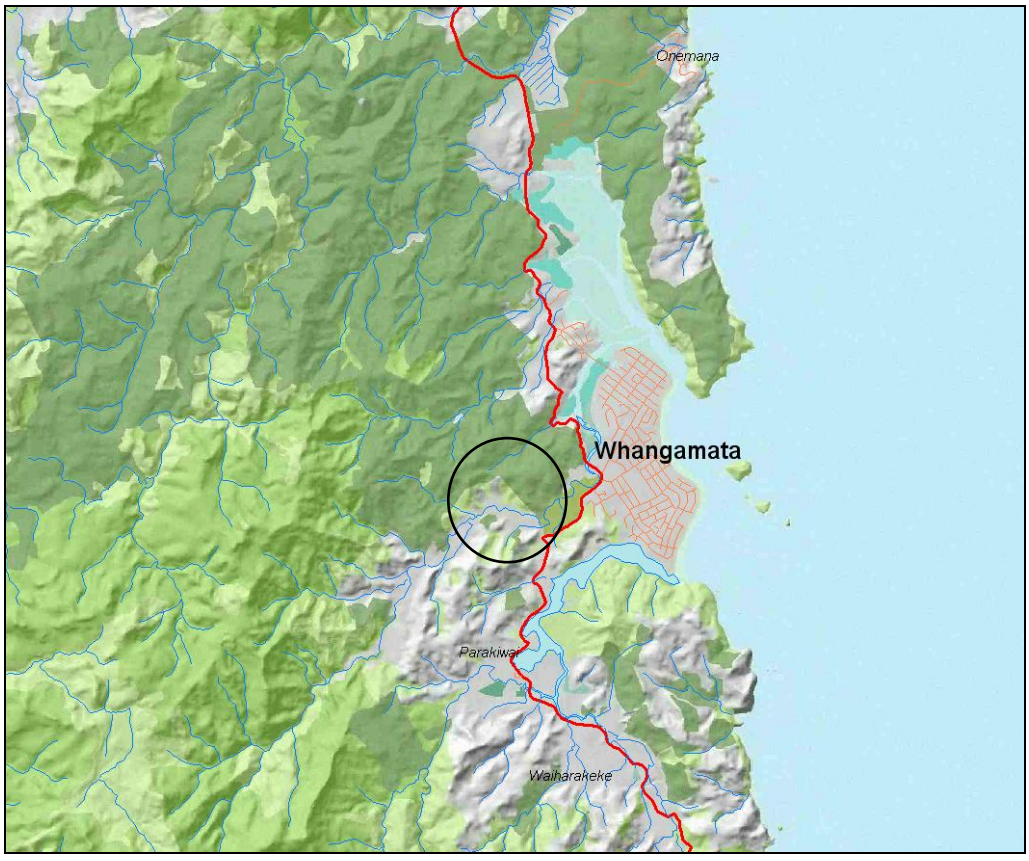

Figure 1 Location Map



Figure 2 Site Map

2 Methodology

2.1 Survey Sites

Two sites were surveyed in detail and a further four were surveyed for fish (six fish survey sites – Figure 2). The vegetation within the wetland area at the North Eastern end of the treatment pond was also surveyed. Two of the six sites surveyed were located immediately above the wastewater treatment pond and two where the stream boarders the pond. Two additional sites were surveyed within the wetland downstream from the treatment pond.

- Site 1 – Upstream from the treatment pond: E 2762280 N 6439726
- Site 2 - Upstream from the treatment pond: E 2762269 N 6439711
- Site 3 - Adjacent from the treatment pond: E 2762290 N 6439780
- Site 4 - Adjacent from the treatment pond: E 2762324 N 6439803
- Site 5 – Downstream from the treatment pond: E 2762378 N 6439833
- Site 6 – Within the wetland: E 2762361 N 6439852

2.2 Survey Methods

2.2.1 Water Quality

Water quality samples were collected and sent to R.J. Hills Laboratories for analysis of the following parameters; Turbidity, Suspended sediments, Total Ammonical-N, Total Nitrogen, Nitrate, Dissolved Reactive Phosphorus (DRP), Total Phosphorus (TP), Biochemical Oxygen Demand (BOD_5), Escherichia coli, Faecal Coliforms, Enterococci.

Ambient and water temperature was collected using a hand held meter in the field. Temperature was collected because it influences many in-stream processes especially in relation to fish. Ph was measured at all sites using a Ph meter and invertebrate samples were taken from each site.

2.3 Stream Morphology, Riparian Vegetation and In-stream Vegetation

At site 1 and 5 a "Field Assessment Form" and "Low Gradient Field Assessment Form" was completed as detailed in the Environment Waikato 'REMS' monitoring guidelines (Kelly & Collier, 2005). The scores for each sheet represent the following characterizations of habitat for in-stream biota:

- Score 180-120 - Excellent to good quality habitat
- Score 120-100 - Moderate to poor quality habitat
- Score 100 or less - Poor to very poor habitat

2.4 Aquatic Macroinvertebrate Composition

At each site a 0.5 mm mesh D-framed hand-net was used to sample aquatic macroinvertebrates. Two replicates were taken per site, from the riffle environment in random placement, moving upstream in accordance with procedures and methods specified as "Protocol C2" in Stark *et al*. (2001). Samples were chilled and preserved in diluted isopropyl alcohol and taken to the laboratory for analysis by a taxonomist. Macroinvertebrate analysis was undertaken using "*Protocol P2 200 Individual Fixed Count with Scan for Rare Taxa*' as described in Stark *et al.* (2001).

Macroinvertebrate analysis was assessed using the following metrics as well as identification and abundance of taxa:

- Macroinvertebrate Community Index (MCI);
- Quantitative Macroinvertebrate Community Index; and
- *Ephemeroptera*, *Plecoptera*, *Trichoptera* (EPT Taxa criteria).

Table 1 provides a summary of relative in-stream ecological health based on these metrics:

Table 1 MCI/QMCI Habitat Score Assessment Chart (after Boothroyd & Stark, 2000)

Macroinvertebrate Community Index Score	Quantitative MCI Index Score	Habitat Quality
>120	> 6.00	Clean water
100 – 119	5.00-5.99	Doubtful quality or possible mild pollution
80-99	4.00-4.99	Probable moderate pollution
<80	< 4.00	Probable severe pollution

2.5 Fish

Fish were surveyed using two different trap nets set overnight (18 h ± 4 h). Both trap nets were baited. Gee-minnow nets are trap nets with a narrow opening designed to capture small fish; these nets were set with perforated containers baited with cat biscuits and marmite. Fyke/eel nets were baited with cat food and meat. Fyke nets were set at three different localities; at Sites 1, 2 and 5. Two G-minnow nets were set at each of the sites except site 2, which had 3, and site 4, which had one. The number of fyke nets and G-minnow set at a site was a function of habitat suitability.

3 Results & Discussion

3.1 Stream Habitat Characterization and In-stream Vegetation

The detailed results of the REMS Habitat Assessment Field Data Sheets are attached as Appendix I.

3.1.1 Site 1 - Above waste water treatment pond

REMS Habitat Assessment Field Data Sheet Score: 135 – Good to excellent quality habitat

Site Features

The stream immediately above the waste water treatment pond has good to excellent quality habitat. The in-stream habitat at this site is variable with a range of depths, substrates and velocities. The water velocity flows rapidly flowing in some sections forming runs and also forms slow running pools. The stream width at this site is 1.5 m within pools and 0.8-0.9 m in runs with a variable depth between 3 cm in the run to 60 cm in the pool. The stream vegetation is composed of a pine canopy (*Pinus radiata*) over pampas (*Cortaderia selloana*) with the occasional manuka (*Leptospermum scoparium*) and mahoe (*Melicytus ramiflorus*).



Figure 3 Site 1

Table 1 Stream sediment composition at Site 1 (05/03/2008)

Inorganic Substrate -

Substrate type	Diameter	Percentage
Bedrock		
Boulder	**>204mm**	
Cobble	**20-204mm**	15%
Gravel	**2-20mm**	25%
Fines	**<2mm**	60%

Organic Substrate -

Substrate type	Characteristic	% Composition
Detritus	**Sticks, wood, coarse**	50%

	plant materials	

3.1.2 Site 5 - Immediately downstream from the treatment pond

REMS Habitat Assessment Field Data Sheet Score: 106- Good quality habitat

Site Features

Site 5 is located several hundred meters downstream of Site 1, the habitat quality decreases from Site 1 to Site 5 as a result of a decrease in the riparian zone width and protection zone and less in stream habitat in the form of pools and debris. The main flow type present at this site is pool with small rapids. The stream at this site has an average width of 2 m where pools are present and decreases to 1 m within the runs. The stream depth is approximately 0.2 m. The vegetation is similar to site one with gorse. The stream edge riparian vegetation is dominated by pampas which overhang the stream providing some shade. *Carex virgata*, gorse (*Ulex europaeus*), *Verbena* and karamu were also present along the riparian zone of the stream. A small amount of starwort (*Callitriche stagnalis*) was present within the stream with larger growths upstream. Some short green filamentous algae and brown periphyton mats were observed on the hard bottom surfaces of the stream bed.

Table 2 Stream sediment composition at Site 5 (0503/2008)

Inorganic Substrate -

Substrate type	**Diameter**	**Percentage**
Bedrock		
Boulder	>204 mm	
Cobble	20-204 mm	15%
Gravel	2-20 mm	25%
Fines	<2 mm	60%

Organic Substrate -

Substrate type	**Characteristic**	**% Composition**
Detritus	Sticks, wood, coarse plant materials	50%



Figure 4 Site 5 with stream edge vegetation dominated by pampas, with a small amount of starwort within the stream

3.2 Water Quality

Ambient and water temperature and pH were collected in the field using a hand held meter on two separate occasions. It was assumed that temperature and pH would change little over the short area between sample sites so parameters were measured upstream and downstream rather than at all sites. The results are displayed in Table 3.

Table 3 Temperature and pH measurements (05/03/2008)

Site No.	Date	Air Temp.(^{0}C)	Water Temp.(^{0}C)	pH
1	16/03/2008	18.9	19.4	7.6
1	24/04/2008	18.3	14.4	-
4	16/03/2008	17.0	16.2	7.0
5	16/03/2008	23.6	14.2	7.3
5	24/04/2008	19.1	14.1	-

The in-stream temperature varies approximately 2°C over the stream sites throughout the day, with the exception of Site 1 measured on the 16/03/08 which is several degrees higher than recorded at Sites 4 and 5 and is warmer than the ambient temperature. Temperatures are known to have a diurnal temperature range similar to air temperature but less variable. The temperature measurements taken in March were recorded during warm drought conditions and can be expected to represent the upper limit of temperature values within this small stream. At Site 1 the March and April temperatures vary 5°C which could be due to thermal heating of the water within pool habitats. However, the water temperatures recorded at Site 5 in March and April are consistent which could be a result of shading of the stream by thick growths of pampas. The temperatures measured are consistent with the slow velocity of the water within the stream (Approximately 0.1m/s). The pH within the un-named tributary of the Waikiekie Stream is consistent and circum-neutral.

Water samples were collected at Sites 1 and 5 located upstream and downstream of the proposed diversion route within the un-named stream. Samples were sent to RJ Hill Laboratories for analysis, the results of which are presented in Table 4.

Results for the Kaupeka Stream, sampled 14 March 2008, have been included as a control. The Kaupeka Stream, at the time of sample collection, was situated among mature pine plantation canopy with secondary native understorey growth. The stream is similar in character and within the same catchment as the un-named tributary sampled during this survey but is located outside of the effect of the WWTP. Therefore, allowing comparison of the catchment water quality that is not effected by the WWTP practices or storage pond.

Turbidity and suspended solid levels within the stream are below ANZECC and aesthetic and contact recreation levels both upstream and downstream of the proposed diversion. However, for unknown reasons both turbidity and suspended solid levels are elevated in the Kaupeka Stream.

The total nitrogen levels are higher than the results for the Waikiekie Stream (Kessels and Aldridge, 2006). It is possible that this stream, which flows into the Waikiekie Stream, may be the source of some of the total nitrogen pollution in the Waikiekie Stream. The elevated total nitrogen levels are elevated as a result of nitrate levels within the stream and are well above ANZEEC guidelines for the 95% level of protection of freshwater aquatic ecosystems. Nitrogen levels are also elevated above the upland and lowland trigger value for chemical stressor for slightly disturbed ecosystems. Nitrate and total nitrogen levels within the Kaupeka Stream were well below guideline levels, possibly indicating WWTP influence.

Ammonium (which is highly toxic to in-stream fauna) levels are slightly higher at the downstream site than the upstream site, but are well below the 95% level of protection of freshwater aquatic ecosystems (ANZECC, 2000) for the un-named tributary and Kaupeka Stream.

The TKN levels were greater downstream of the pond within the un-named tributary stream of the Waikiekie.

Dissolved reactive phosphorous levels within the stream were below detection and well below the ANZECC guidelines for the 95% level of protection of freshwater aquatic ecosystems.

The Carbonaceous Biological Oxygen Demand (BOD_5) was below detection at the upstream site and slightly above detection at the downstream site. Both BOD_5 results were below ANZECC guidelines, indicating low organic pollution inputs.

Faecal coliform and Enterococci levels were much greater in the sample collected at Site 5, downstream of the storage pond. Enterococci had a ten fold increase from upstream to downstream. The Faecal coliform levels at the downstream site are elevated above stock water supply and contact recreation (ANZECC, 2000). Faecal coliform and Enterococci levels within the control Kaupeka Stream are well below ANZECC guidelines.

Table 4 Water quality results tested at RJ Hill Laboratories

Water Quality Parameter	Units	Kaupeka (14.03.06)	Site 1 Upstream	Site 5 Downstream	Guideline Standard	Ref. & Comments
Turbidity	NTU	9.01	3.3	4.1	5.6	Upland Rivers 4.1, Lowland Rivers 5.6. ANZECC 2000 Aquatic ecosystems volume 1 pages 3-18
pH		7.1	6.9	7.0		
Electrical Conductivity	mS/m	-	19	19		
Suspended Sediments (SS)	g.m-3	5	<3.0	<3.0	< 4g/m^3	Smith *et al* 1993 – Aesthetics & contact recreation
Total Ammoniacal-N (NH4N)	g.m-3	0.12	<0.010	0.063	< 0.9g/m^3	ANZECC 2000 –95% level of protection of freshwater aquatic ecosystems
Total Nitrogen (TN)	g.m-3	0.0419	3.3	3.4	0.295g/m^3 0.614g/m^3	ANZECC 2000 – Upland River trigger value for chemical stressor for slightly disturbed ecosystems ANZECC 2000 – Lowland River trigger value for chemical stressor for slightly disturbed ecosystems
Total Kjedahl Nitrogen (TKN)	g.m-3	-	0.19	0.27		
Nitrite-N	g.m-3	-	<0.0020	0.0031		
Nitrate-N (NOxN)	g.m-3	0.0419	3.1	3.1	< .7g/m^3	ANZECC 2000 –95% level of protection of freshwater aquatic ecosystems
Nitrate-N + Nitrite-N	g.m-3	-	3.1	3.1		
Dissolved Reactive Phosphorous (DRP)	g.m-3	<0.004	<0.0040	<0.0040	<0.033g/m^3	ANZECC 2000 – 95% level of protection of freshwater aquatic ecosystems
Total Phosphorus	g.m-3	0.009	0.014	0.018		
Carbonaceous Biological Oxygen Demand ($CBOD_5$)	g.O_2 m-3	<1	<1.0	1.2	5	ANZECC 2000 – Physicochemical stressor guideline for protection of aquaculture species
Faecal Coliforms	Cfu/100mL	45	110	250	<150/100 mL <100mL/100mL	ANZECC 2000 - Contact Recreation Stock water supply
Enterococci	Cfu/100mL	3	30	300	N/A	

3.3 Invertebrates

Five macroinvertebrate samples were collected within a tributary of the Waikiekie Stream which runs adjacent to the Whangamata WWTP storage pond. The MCI value of the stream provides a biological indication of the health of the stream. MCI values within the range of values in Table 4 below indicate pollution. All samples fall within a narrow band of values between 80 and 90 this indicates probable moderate pollution. All sites low diversity, particularly Sites 1 and 6 as indicated by the low number of taxa present.

Of interest is the absence of EPT taxa at Site 2, which is a measure of the diversity of stoneflies, mayflies and caddisflies within the stream. The Mollusc *Potamopyrgus* is the dominant macroinvertebrate within this tributary stream, freshwater shrimp or *Parataya* were also relatively common in all samples collected.

One pollution sensitive *Ptilodactylidae* bettle was present in the sample collected at Site 2, along with the pollution tolerant true fly Orthocladiinae. The pollution tolerant caddisfly Oxyethira was present in low numbers at Sites 1, 4, 5 and 6.

The Kaupeka Stream, sampled on 14 March 2006, can be used as a control for macroinvertebrates. This control site had a higher MCI value of 102 indicating moderate to poor stream health (Kessels and Aldridge, 2006), as outlined by the habitat score assessment chart (after Boothroyd and Stark, 2000). Taxa diversity was greater in the control site with a taxa number of 14.8. The %EPT was much greater within the control sites with a value of 15% for the number of individuals, which is several times greater than those recorded in the un-named tributary.

Table 5 Results of the macroinvertebrate samples collected on the 05/03/2008

	Site 1	Site 2	Site 4	Site 5	Site 6
Number of Taxa	**5**	**8**	**9**	**7**	**4**
Number of individuals	159	191	127	153	214
EPT Value	**2**	**0**	**4**	**3**	**1**
% EPT (taxa number)	**40.0%**	**0.0%**	**44.4%**	**42.9%**	**25.0%**
%EPT (numbers of individuals)	**1.9%**	**0.0%**	**4.7%**	**3.3%**	**1.4%**
Sum of recorded taxa scores	21	36	37	29	16
MCI Value	**84.0**	**90.0**	**82.2**	**82.9**	**80.0**
Sum of abundance loaded scores	657.0	768.0	510.0	637.0	893.0
QMCI Value	**4.13**	**4.02**	**4.02**	**4.16**	**4.17**
	17.5	35.6	35	28.1	11.5
MCI-sb Value	**70.0**	**89.0**	**77.8**	**80.3**	**57.5**
	373.0	469.7	296.1	393.3	521.2
QMCI-sb	**2.35**	**2.46**	**2.33**	**2.57**	**2.44**

3.4 Fish

Large numbers of banded kokopu (*Galaxias fasciatus*) and red finned bully (*Gobiomorphus huttoni*) were caught all along the stream length (Table 6). Redfin bullies reside in cobble/boulder streams with a swift water velocity (McDowall, 2000). Shrimp (*Paratya*) were also found to be abundant throughout the area. Two longfin eel (*Anguilla dieffenbachii*) captured at Sites 5 and 1 had lengths of 825 mm and 724 mm and a weight of 1700 g and 1190 g respectively.

Banded kokopu prefer to reside in streams with ample riparian coverage and are often found close to the coast because of their poor climbing ability. The banded kokopu is one of the five species that make up the whitebait run in New Zealand. Banded kokopu have been included on the threatened species list in the past (Tisdall, 1994) but are no longer considered to be nationally threatened (Hitchmough, 2002), however, these fish are often locally rare. The longfin eel is considered to be a threatened species in gradual decline (Tisdall, 1994) listed as a “Chronically threatened species in gradual decline” by Hitchmough (2002). There appears to be a lack of recruitment (addition of new young of the year) of the longfin eel at this site as no juveniles were captured. This may be due to predation, water quality or preferred habitat. Large longfin eels such as the two captured at Sites 1 and 5 are known to be predatory on other fish for at least a portion of their diet, this includes

cannibalism (McDowall, 1978). Longfin eels are characteristic of inland streams and usually reside in faster flowing stony streams, although they can be found in all types of habitats (McDowall, 1978). The presence of undercut banks at the site provides good habitat for both the banded kokopu and the longfin eel.

Table 6 Capture rate of banded kokopu and red finned bully (05/03/2008)

Banded kokopu

	Site 1		Site 2		Site 3	Site 4	Site 5		Site 6
Type of Net Used	**G-minnow**	**Fyke**	**G-minnow**	**Fyke**	**G-minnow**	**G-minnow**	**G-minnow**	**Fyke**	**G-minnow**
No. of nets/traps	2	1	3	1	2	1	2	1	2
Catch per unit effort	0.0	37.0	116.0	87.0	15.0	0.0	42.3	0.0	77.0

Red Finned Bully

	Site 1		Site 2		Site 3	Site 4	Site 5		Site 6
Type of Net Used	**G-minnow**	**Fyke**	**G-minnow**	**Fyke**	**G-minnow**	**G-minnow**	**G-minnow**	**Fyke**	**G-minnow**
No. of nets/traps	2	1	3	1	2	1	2	1	2
Catch per unit effort	11.5	4.5	3.8	0.0	5.0	1.5	8.3	5.5	6.8

Catch per unit effort (CPUE) has been calculated for the red finned bully and banded kokopu caught at the six sites. The CPUE (Table 5) shows variation across the sites without any specific increasing or decreasing trend upstream or downstream from the treatment pond. Observed differences are instead likely to be due to differences in habitat preferences rather than any strong upstream or downstream affects from the treatment pond.

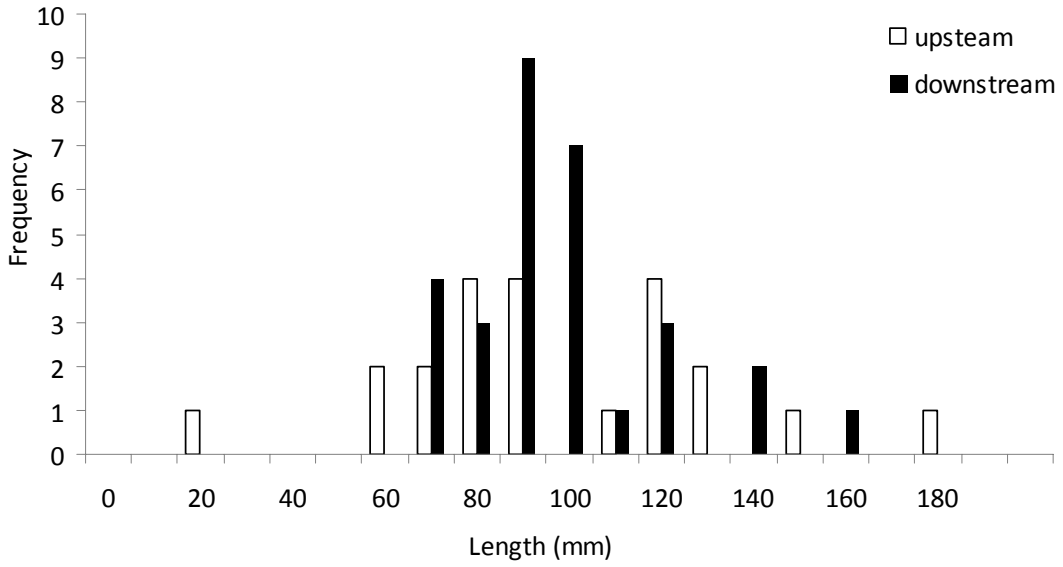

Figure 5 Population structure of banded kokopu along the stream length

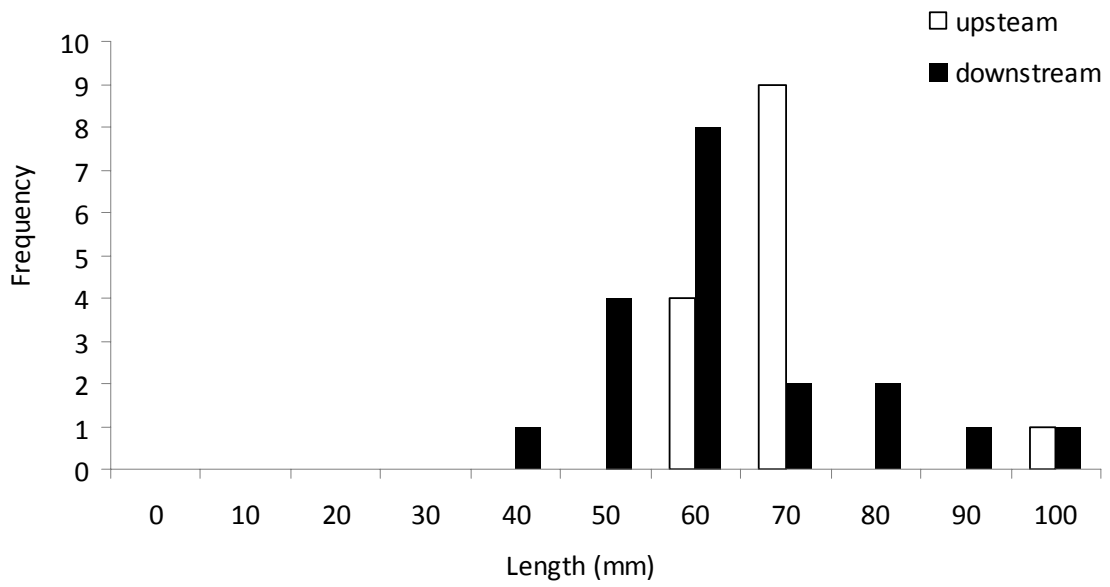

Figure 6 Population structure of red finned bully along the stream length

The population structure of the most abundant fish caught, red finned bully and banded kokopu, can be seen in Figures 5 and 6. This survey shows abundant juvenile and adult throughout the section of stream surveyed indicating recruitment. This area is likely to be important spawning habitat for these fish species. Both species are migratory and close proximity to the ocean will enhance numbers within the study streams. Inland streams are unlikely to have as high numbers as coastal streams as access may be limited by downstream barriers.

Table 7 Freshwater fish database (FFDB) records for Waikiekie Stream (extracted 04/04/2008)

Fish Species				
Common name	**Scientific name**	**Year**	**General abundance**	**Occurrence in tributary**
Shortfin eel	*Anguilla australis*	1993	occasional	Likely
Longfin eel	*Anguilla dieffenbachii*	1982, 1993	common	Yes
Torrentfish	*Cheimarrichthys fosteri*	1985	occasional	Unlikely
Giant kokopu	*Galaxias argenteus*	1985	rare	Likely
Banded kokopu	*Galaxias fasciatus*	1985	occasional	Yes
Inanga	*Galaxias maculatus*	1985	occasional	Likely
Cran's bully	*Gobiomorphus basalis*	1985, 2001	common	Possibly
Common bully	*Gobiomorphus cotidianus*	2001	occasional	Likely
Redfin bully	*Gobiomorphus huttoni*	2001	abundant	Yes
Koura	*Parenophrops*	2001	occasional	Yes
Smelt	*Retropinna retropinna*	2000, 2001	common	Unlikely

A FFDB search was undertaken on the Waikiekie Stream to determine fish species that occur within the stream and therefore may be present within the tributary stream sampled during this survey. The results for the Waikiekie Stream are presented in Table 7. The Waikiekie Stream flows into the ocean at Whangamata Harbour and encompasses a wider range of habitats along its reach, which accounts for the species diversity. Ten fish species as well as freshwater crayfish (koura) have been caught within the Waikiekie stream. Several of these species are also likely to occur within the stream sampled during this survey (in addition to the species captured), these include; shortfin eel, giant kokopu, inanga, bully species and koura. Shortfin eel are known to be a pollution tolerant species that live in lowland habitats and often attain high biomass in pasture streams with high

nutrient levels. Giant kokopu are considered to be a threatened species (Tisdall, 1994; Hitchmough, 2002) they are solitary and nocturnal often found in slow flowing pools. The habitat within the streams was considered ideal for giant kokopu and these species may be present here. Torrentfish are unlikely to be caught within the sample area as suitable habitat for this species was not available. Torrentfish prefer swift flowing gravel/cobble bottom streams. Smelt are also unlikely to be captured at this site as they are poor climbers and are usually found occupying estuaries and lowland rivers in large shoals.

Kessels and Associates Surveyed the Waikiekie, Otuwheti and Kaupeka Stream in the vicinity of the Whangamata WWTP in March of 2006. The results of these fishery surveys was that banded kokopu were the dominant fauna found in the well shaded streams which had abundant cover in the form of undercut banks and small pools (Kessels & Aldridge, 2006). Longfin eel, redfin bully and koura were found to be common during the 2006 survey.

3.5 Wetland vegetation

The downstream wetland area consists of two main vegetation types. Small-leaved-broadleaved scrub covers the surrounding slopes and a slim strip along the northern margin while the central wetland area is covered by shorter freshwater wetland vegetation.

Small-leaved-broadleaved scrub

The side slopes of the wetland area are mainly covered by 4-6 m tall manuka in various stages of regeneration (Figure 7 overleaf). The younger and denser areas and especially the flat north-western corner of the area at the conversion to the central part of the wetland have a pampas dominated understorey mixed with native toetoe (*Cortaderia fulvida*) and *Carex geminata*. Common native understorey species include putaputaweta, four different *Coprosma* species (*C. robusta*, *C. grandifolia*, *C. tenuicaulis* and *C. spathulata*), koromiko, juvenile forest cabbage tree (*Cordyline banksii*) and ponga. The fern mangemange occasionally climbed up the stems. Some tall mamaku, cabbage tree, mahoe, mapou and hangehange grow along the boundary to the central wetland area. The groundcover includes seedlings of the named tree and shrub species as well as the ferns *Gleichenia dicarpa*, kiokio and ring fern. Pink bindweed (*Calystegia sepium*) occurs occasionally. Grasses include bamboo grass, hookgrass as well as common pasture grasses (*Holcus lanatus*, *Dactylis glomerata*, *Paspalum distichum*).

The dry side slopes also support saplings and seedlings of mahoe, rewarewa, mapou and pigeonwood. Common and prickly mingimingi as well as rangiora were found throughout. *Miscanthus nepalensis* and *Gahnia xanthocarpa* were common grasses while present herbs included *Nertera villosa* as well as common pasture species e.g. *Lotus pedunculatus*. *Dianella nigra* and *Baumea tenax* are present on the drier soils while and *B. rubiginosa* grows closer to the central wetland area.

Present weed species include Spanish heath (*Erica lusitanica*), *Cyperus eragrostis*, ragwort, purple top (*Verbena bonariensis*) and aristea (*Aristea ecklonii*).



Figure 7 The small-leaved scrub on the north-western margin of the wetland

Central wetland area

The central wetland area is dominated by two different species of pampas (*Cortaderia selloana* and *C. Jubata*, Figure 8 overleaf). However, native species like the similar looking toetoe, the sedges *Carex geminata*, *C. secta*, raupo and flax are also present. Some tall manuka as well as cabbage trees grow scattered towards the north end of the wetland area. The occasional young wilding pine occurs along the southern edge. Present grasses and rushes include the pasture species *Juncus effusus*, Holcus lanatus and *Dactylis glomerata*. Other species present include swamp fern (*Thelypteris confluens*), *Ficinia nodosa, Solanum nigrum,* Scotch thistle (*Cirsium arvense*), purple top*, Haloragis erecta, Baumea rubiginosa* and Willow weed (*Persicaria persicaria*).

Pig sign was noted in this area.



Figure 8 The central pampas dominated section of the wetland

Vegetation on proposed cut face

The proposed cut face is currently covered by pine plantation over treeferns and pampas and occasional re-growing native trees and shrubs, such as manuka, mahoe, mapou and mingimingi (Figure 9). The exotic Himalayan fairy grass (*Miscanthus nepalensis*) is common in the groundcover as are *Baumea tenax, Lycopodiella cernua* and NZ blueberry (*Dianella nigra*).



Figure 9 Pine canopy over treefern understorey on proposed cut face

Vegetation within the proposed southern diversion option

Pampas and manuka dominate the vegetation in this area with occasional emerging pines and gorse (Figure 10). The understorey has *Baumea tenax, Lycopodiella cernua* and NZ blueberry, as well as a range of exotic species, namely Himalayan fairy grass, aristea and Spanish heath.



Figure 10 vegetation composition along the southern end of the treatment pond

4 Conclusions and Key Impacts

4.1 Conclusions

The tributary of the Waikiekie Stream that runs adjacent to the Whangamata WWTP storage pond is considered to have moderate to poor water, good habitat quality, and supports high fish densities. The poor water quality is indicated by the low diversity of macroinvertebrate fauna and relatively high proportion of pollution tolerant species. Ideal habitat within the stream is utilised by an abundant population of redfin bullies and banded kokopu. The high density of fish is a function of close proximity to the ocean and accessibility (i.e. no significant barriers downstream to the ocean).

The vegetation in the immediate vicinity of the storage pond and stream area is dominated by pine trees and exotics and therefore holds little ecological value.

Diversion of the stream will create a loss in habitat for banded kokopu and redfin bully species, and although these fish are relatively common in the study area, appropriate measures should be employed to protect the stream life.

A length of stream, equal or greater in length to that being lost, needs to be replaced as part of a stream diversion. High quality fish habitat will be lost and will need to be replaced within the newly created stream. Since 240 m of stream will be lost and replaced with 214 m it is recommended that a length of at least 26 m downstream of the newly diverted stream is enhanced. Enhancement

should take the form of pampas removal and control as well as planting a riparian of native trees in the riparian zone of the stream in the wetland.

As stated in the introduction there are two alternative routes for the stream diversion. The eastern diversion follows the proposed extended edge of the storage pond to the wetland area, while the western diversion will flow behind the pump station to the Waikiekie Stream. The eastern diversion is preferred to avoid native scrub clearance and to aid enhancement and restoration of the wetland area.

4.2 Key Ecological Effects of the Proposed Diversion

The additional storage and associated works near the existing retention pond in Whangamata will require the existing stream diversion along the southern face of the existing retention pond to be diverted around the extended pond. The stream provides habitat for several native fish species, including longfin eel, banded kokopu, and red finned bully, as well as shrimp. The most significant habitat utilisation is by banded kokopu, which use the stream to spawn and for recruitment. Some 240 m of the proposed stream infill contains high quality banded kokopu habitat. In addition the proposed plan will require wetland and scrub/pine clearance. The potential stream diversion will also impact on the wetland reducing water inflow and impeding upstream fish passage. If water inflow is reduced significantly the wetland will become drier leading to vegetation changes and associated invertebrate composition changes.

Effects during construction are primarily related to disturbance of the streambeds and sediment runoff from excavations in the surrounding hills with road, and culvert construction. Construction will require a substantial amount of earthworks and minor vegetation removal (likely to be less than 0.5ha). Care will also be needed when using concrete within the stream as concrete is highly toxic to fish when fresh.

The potential adverse effects of these works on the biota of the receiving stream could be significant without the implementation of suitable sediment control measures. Standard good practice measures, such as sediment ponds, well placed geo-textile material and swales/berms would reduce sediment run-off from the construction sites to acceptable concentrations, provided that they are well designed and regularly monitored and maintained. Monitoring during construction will ensure that any potential erosion problem areas are identified at an early stage. Appropriate contingency measures can then be undertaken quickly.

A silt control management plan is recommended in order to provide direction and construction standards for the contractors during construction.

The proposed diversion would result in the loss of riparian margin values for the affected reach only where the proposed culvert crossing occurs. The aquatic biota and wildlife corridor functions of this riparian margin vegetation will be diminished with the construction of the proposed pond extension and stream diversion. Removal of this riparian margin vegetation would need at least equivalent replacement or enhancement elsewhere along the stream.

4.3 Possible mitigation options

The following specific measures should be included in any consent conditions and management plans or processes.

a) Before construction, the affected reach of the stream should be fished and all fish captured should be transferred to similar habitat elsewhere within the stream. A possibility is placement of the fish above the realignment, with the fish being blocked from the stream with a net.

b) Stormwater from all exposed cuts, fills and preloads shall be diverted through silt traps (i.e., geotextile barriers or hay-bale bunds) in accordance with Environment Waikato recommended design standards for sediment control. A silt control management plan is recommended in order to provide direction and construction standards for the contractors during construction.

c) The loss of 240 m of stream habitat needs to be mitigated for. The implementation of a new stream replicating the length of stream to be removed with a proposed riparian planting plan will achieve this mitigation provided that the length of the stream lost is at least equal to that being replaced and is replanted. The created stream should follow a natural meandering path with similar widths and depths to the existing stream. Pool, riffle and run habitat should be recreated to provide habitat for a number of fish species. Banded kokopu are fish that reside in small pools under abundant overhead cover. Small pools should be created for this species with the addition of suitably placed logs and boulders. Logs should be placed on bank edges and held in place to provide habitat cover for fish species. Shallow riffles should be created and maintained with cobble to gravel sized sediment. Riparian cover over the stream will provide habitat, decrease periphyton growth on rock surfaces and provide a terrestrial food source for fish species.

d) Improving biodiversity by weed control and replanting of natives.

e) Enhancing water flows by strategic placement of bunds to raise water levels within the wetland.

Based on previous stream diversions undertaken by Kessels & Associates ecologists we have a high degree of confidence that creating new stream channels and translocating fish can replicate and even enhance existing ecosystems for sensitive native fish.

In addition:

- All machinery shall be in good working order with no leaking hydraulic or fuel systems.
- Refuelling shall be carried out at least 20 metres from any watercourse. All refuelling shall be undertaken at designated fuel refill sites.

5 References

Biggs, B. J.; Kilroy, C. 2000. Stream periphyton monitoring manual. Prepared for Ministry for the Environment. NIWA, Christchurch. 229 p.

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McDowall, R. M. 2000. The Reed field guide to – New Zealand freshwater fishes. Reed Publishing (NZ) Ltd, Auckland.

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Appendix I

Field Assessment Sheets

FIELD ASSESSMENT COVER FORM: (100m reach)
WADEABLE HARD-BOTTOMED AND SOFT-BOTTOMED STREAMS

STREAM NAME:		**ASSESSOR: GGK/GGH**	
SITE NUMBER: Site 1	**SAMPLE NUMBER:**	**DATE: 06/03/08**	**TIME (NZST): 12.15pm**

GPS COORDINATES: **Downstream end of reach - Easting –** **Northing –**
Upstream end of reach - Easting – **Northing –**

Canopy Cover:
μ Open μ Partly shaded μ Significantly shaded

Riparian Fencing: **Dominant rip.landuse (≤20m)(**
μ None/ ineffective
μ One side/ partial both sides
μ Complete both sides

μ Urban	μ Retired Grass
μ Parkland	μ Forestry
μ Crops/hort	μ Native shrub
μ Pasture	μ Native forest

INSTREAM HYDRAULIC CONDITIONS

Estimated reach average conditions:
Stream width (C) _____ m
Stream width (W) _____ m
Stream depth _____ m
Surface velocity _____ m/sec

Temperature: H2O: 18.9 °C; Ambient 19.4 °C Conductivity: _____μS/cm μ Ambient
Dissolved Oxygen: _____ % _____ mg/L μ Adjusted to 25ºC
Turbidity: μ Clear μ Slightly turbid μ Highly turbid μ Stained μ Other_____

INORGANIC SUBSTRATE

Compaction
μ assorted sizes tightly packed &/or overlapping
μ moderately packed with some overlap
μ mostly a loose assortment with little overlap
μ no packing / loose assortment easily moved.

Embeddedness
μ <5% gravel-boulder particles covered by fine sediment
μ 5-24% covered by fine sediment
μ 25-49% covered by fine sediment
μ 50-75% covered by fine sediment
μ >75% covered by fine sediment

% surficial substrate size composition
(should sum to 100%)

Substrate type	Diameter	Percentage
Bedrock	-	
Boulder	> 256mm	
Cobble	>64-256mm	**15**
Gravel	>2-64mm	**25**
Sand	>0.06-2mm	25
Silt	0.004-0.06mm	**25**
Clay	<0.004mm	**10**

ORGANIC SUBSTRATE
(% cover in reach - need not sum to 100%)

Large wood (>10 cm diameter): _____%
Detritus (small wood, sticks, leaves etc > 1 mm): 50%
Muck/mud (fine organic matter < 1 mm): _____%

HABITAT TYPES SAMPLED (% of effort; each column should sum to 100%)
Stones: _____% Riffles: _____%
Wood: _____%
Macrophytes: _____%
Edges: _____% Runs: _____%

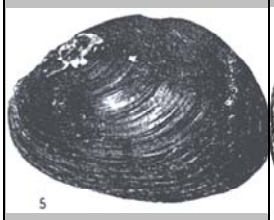
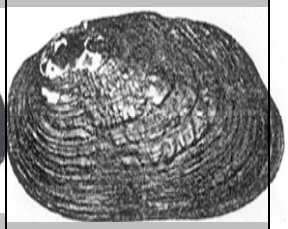
COMMENTS
Manuka (pine canopy over pamps occ mamaka, some rampa, comex fern, wheki 12m) Eio kio,
Lot ped, comvalualeus, Opl Hir, Jun elf, Car dis,
On side slopes: mahoe, Supe megpou, Bra rep, Carex sp. Ital eve

Water
Ph : 7.6

Depth 3.2 mm Pool 600 mm
Width 1.5 m (pool) mm 800-900 mm

NO. INVERTEBRATES RETURNED TO STREAM
Koura: _____ Shrimps: abundant
Crabs: _____ Mussels: _____
Others (specify) _____

Species of mussel (tick)

Hyridella	*Cucumerunio*
	
Shell smooth; up to 100mm long; variable shell shape	*Nodules and ridges on upper part of shell; up to 90mm long*

WADEABLE SOFT-BOTTOMED STREAMS – 100 m reach

Qualitative Habitat Assessment Field Data Sheet

STREAM NAME:	**SITE NUMBER:**
SAMPLE NUMBER: **Site 1** **ASSESSOR:** **GGK/GGH**	**DATE: 06/03/08**

Habitat Parameter	**Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Riparian Vegetative Zone Width (score each bank riparian zone)	• Bankside vegetation buffer is >10m • Continuous and dense	• Bankside vegetation buffer is <10m • Mostly continuous	• Pathways present and/or stock access to stream • Mostly healed over	• Breaks frequent • Human activity obvious
SCORE _18__(LB)	20 19 **18** 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
SCORE _18__(RB)	20 19 **18** 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB&RB__18___				
2. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	• Bank surfaces and immediate riparian zones covered by native vegetation • Trees, understorey shrubs, or non-woody plants present • Vegetative disruption minimal	• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry	• 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 streambank vegetation very high • Grass heavily grazed • Significant stock damage to the bank
SCORE ___(LB)	20 19 **18** 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
SCORE ___(RB)	20 19 **18** 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB&RB_18___				
3. Bank Stability (score each bank) Note: determine left of right side by facing downstream	• 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
SCORE ___(LB)	20 19 **18** 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
SCORE ___(RB)	20 19 **18** 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB&RB_18__				
4. **Channel sinuousity**	• Bends increase stream length 3-4 times longer than if it was in a straight line	• Bends increase the stream length 2-3 times longer than if it was in a straight line	• Bends increase the stream length 1-2 times longer than if it was in a straight line	• Channel straight
SCORE 13_	20 19 18 17 16	15 14 **13** 12 11	10 9 8 7 6	5 4 3 2 1

SUBTOTAL : __67_____

Soft bottomed continued

Habitat Parameter	5.1.1.1.1 Category			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
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 to 80% of reach channelised and disrupted	• Banks shored with gabion or cement • >80% of the stream reach channelised and disrupted. • Instream habitat altered or absent
SCORE _15__	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Sediment Deposition	• Little/no islands or point bars present • <20% of the bottom affected by sediment deposition	• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of the 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 obstructions, constrictions, and bends	• Heavy deposits of fine material • Increased bar development • >80% of the bottom changing frequently • pools almost absent due to sediment deposition
SCORE _11__	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Pool Variability	• Pools evenly mixed • Large/shallow, Large/deep, Small/shallow, Small/deep	• Majority of pools large/deep • Very few shallow pools	• Prevalence shallow pools	• Majority of pools small/shallow
SCORE _16__	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 invertebrate colonisation and wide variety of woody debris, riffles, root mats, snags/submerged logs/undercut banks/cobbles. • Substrate provides abundant fish cover • Must be not new and not transient	• 30-50% substrate favourable for invertebrate colonisation • Snags/submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material	• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved 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 limited to macrophytes
SCORE __10_	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 hand held stones • Stable substrate • Surfaces rough to touch	• Periphyton not visible on stones • Stable substrate • Periphyton obvious to touch	• Periphyton visible • <20% cover of available substrate	• Periphyton obvious and prolific • >20% cover of available substrate
SCORE _16__	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Total Score _135	NB: Use only means of LB and RB values			

FIELD ASSESSMENT COVER FORM: (100m reach)
WADEABLE HARD-BOTTOMED AND SOFT-BOTTOMED STREAMS

STREAM NAME:		ASSESSOR: GGK/GGH/ WG	
SITE NUMBER: Site 5	SAMPLE NUMBER:	DATE: 06/03/08	TIME (NZST): 1.15pm

GPS COORDINATES: Downstream end of reach - Easting – Northing –
Upstream end of reach - Easting – Northing –

Canopy Cover:

μ Open μ Partly shaded μ Significantly shaded

Riparian Fencing: **Dominant rip.landuse (≤20m)(**

μ None/ ineffective

μ One side/ partial both sides

μ Complete both sides

μ Urban	μ Retired Grass
μ Parkland	μ Forestry
μ Crops/hort	μ Native shrub
μ Pasture	μ Native forest

INSTREAM HYDRAULIC CONDITIONS

Estimated reach average conditions:

Stream width (C) _____ m
Stream width (W) _____ m
Stream depth _____ m
Surface velocity _____ m/sec

Temperature: H2O: 14.2 °C; Ambient 23.6 °C Conductivity: _____μS/cm μ Ambient
Dissolved Oxygen: _____ % _____ mg/L μ Adjusted to 25ºC
Turbidity: μ Clear μ Slightly turbid μ Highly turbid μ Stained μ Other_____

INORGANIC SUBSTRATE

Compaction

μ assorted sizes tightly packed &/or overlapping
μ moderately packed with some overlap
μ mostly a loose assortment with little overlap
μ no packing / loose assortment easily moved.

Embeddedness

μ <5% gravel-boulder particles covered by fine sediment
μ 5-24% covered by fine sediment
μ 25-49% covered by fine sediment
μ 50-75% covered by fine sediment
μ >75% covered by fine sediment

% surficial substrate size composition
(should sum to 100%)

Substrate type	Diameter	Percentage
Bedrock	-	
Boulder	> 256mm	
Cobble	>64-256mm	**15**
Gravel	>2-64mm	**25**
Sand	>0.06-2mm	25
Silt	0.004-0.06mm	**25**
Clay	<0.004mm	**10**

ORGANIC SUBSTRATE
(% cover in reach - need not sum to 100%)

Large wood (>10 cm diameter): _____%
Detritus (small wood, sticks, leaves etc > 1 mm): 50%
Muck/mud (fine organic matter < 1 mm): _____%

HABITAT TYPES SAMPLED (% of effort; each column should sum to 100%)

Stones: _____% Riffles: _____%
Wood: _____%
Macrophytes: _____%
Edges: _____% Runs: _____%

COMMENTS

Manuka (pine canopy over pamps occ mamaka, some rampa, comex fern, wheki 12m) Eio kio,
Lot ped, comvalualeus, Opl Hir, Jun elf, Car dis,
On side slopes: mahoe, Supe megpou, Bra rep, Carex sp. Ital eve

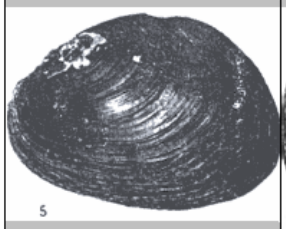
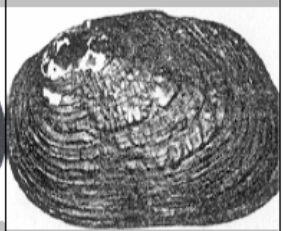
Water
Ph :7.3

Depth 3.2 mm Pool 600 mm
Width 1.5 m (pool) mm 800-900 mm

NO. INVERTEBRATES RETURNED TO STREAM

Koura: _____ Shrimps: abundant
Crabs: _____ Mussels: _____
Others (specify) _____

Species of mussel (tick)

Hyridella	*Cucumerunio*
	
Shell smooth; up to 100mm long; variable shell shape	*Nodules and ridges on upper part of shell; up to 90mm long*

WADEABLE SOFT-BOTTOMED STREAMS – 100 m reach

Qualitative Habitat Assessment Field Data Sheet

STREAM NAME:	**SITE NUMBER:**
SAMPLE NUMBER: **Site 5** **ASSESSOR:** **GGK/GGH**	**DATE: 06/03/08**

Habitat Parameter	**Category**			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
1. Riparian Vegetative Zone Width (score each bank riparian zone)	• Bankside vegetation buffer is >10m • Continuous and dense	• Bankside vegetation buffer is <10m • Mostly continuous	• Pathways present and/or stock access to stream • Mostly healed over	• Breaks frequent • Human activity obvious
SCORE _5__(LB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
SCORE _16__(RB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB&RB__10.5___				
2. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	• Bank surfaces and immediate riparian zones covered by native vegetation • Trees, understorey shrubs, or non-woody plants present • Vegetative disruption minimal	• Bank surfaces covered mainly by native vegetation • Disruption evident • Banks may be covered by exotic forestry	• 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 streambank vegetation very high • Grass heavily grazed • Significant stock damage to the bank
SCORE 11 (LB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
SCORE 16 (RB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB&RB_13.5				
3. Bank Stability (score each bank) Note: determine left of right side by facing downstream	• 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
SCORE 14_(LB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
SCORE 14_(RB)	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Mean LB&RB_14__				
4. **Channel sinuousity**	• Bends increase stream length 3-4 times longer than if it was in a straight line	• Bends increase the stream length 2-3 times longer than if it was in a straight line	• Bends increase the stream length 1-2 times longer than if it was in a straight line	• Channel straight
SCORE 9_	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

SUBTOTAL : 47

Soft bottomed continued

Habitat Parameter	*5.1.1.1.2 Category*			
	Optimal	**Suboptimal**	**Marginal**	**Poor**
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 to 80% of reach channelised and disrupted	• Banks shored with gabion or cement • >80% of the stream reach channelised and disrupted. • Instream habitat altered or absent
SCORE _13__	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
6. Sediment Deposition	• Little/no islands or point bars present • <20% of the bottom affected by sediment deposition	• New increase in bar formation, mostly from gravel, sand or fine sediment • 20-50% of the 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 obstructions, constrictions, and bends	• Heavy deposits of fine material • Increased bar development • >80% of the bottom changing frequently • pools almost absent due to sediment deposition
SCORE _12__	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Pool Variability	• Pools evenly mixed • Large/shallow, Large/deep, Small/shallow, Small/deep	• Majority of pools large/deep • Very few shallow pools	• Prevalence shallow pools	• Majority of pools small/shallow
SCORE _12__	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 invertebrate colonisation and wide variety of woody debris, riffles, root mats, snags/submerged logs/undercut banks/cobbles. • Substrate provides abundant fish cover • Must be not new and not transient	• 30-50% substrate favourable for invertebrate colonisation • Snags/submerged logs/undercut banks/cobbles • Fish cover common • Moderate variety of habitat types. Can consist of some new material	• 10-30% substrate favourable for invertebrate colonisation • Fish cover patchy • 60-90% substrate easily moved 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 limited to macrophytes
SCORE __12	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 hand held stones • Stable substrate • Surfaces rough to touch	• Periphyton not visible on stones • Stable substrate • Periphyton obvious to touch	• Periphyton visible • <20% cover of available substrate	• Periphyton obvious and prolific • >20% cover of available substrate
SCORE _10__	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Total Score _106	NB: Use only means of LB and RB values			

Appendix II

Water Quality Results

Hill Laboratories
A WORLD LEADER IN ANALYTICAL SERVICES

R J Hill Laboratories Limited
1 Clyde Street
Private Bag 3205
Hamilton 3240, New Zealand

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Kessels & Associates Ltd	**Lab No:**	639923 SPv1
Contact:	Aldridge, Brenda	**Date Registered:**	26-Apr-2008
	c/o Kessels & Associates Ltd	**Date Reported:**	19-May-2008
	575 Grove Road	**Quote No:**	
	RD 5	**Order No:**	
	HAMILTON	**Client Reference:**	Whangamata WWTP
		Submitted By:	Aldridge, Brenda

Sample Type: Clean waters

Sample Name:		Whangamata WWTP Site 1 Upstream 24-Apr-2008 12:30 pm	Whangamata WWTP Site 5 Downstream 24-Apr-2008 1:00 pm			
Lab Number:		639923.1	639923.2			
Turbidity	NTU	3.3	4.1	-	-	-
pH	pH Units	6.9	7.0	-	-	-
Electrical Conductivity (EC)	mS/m	19	19	-	-	-
Total Suspended Solids	g/m³	< 3.0	< 3.0	-	-	-
Total Nitrogen	g/m³	3.3	3.4	-	-	-
Total Ammoniacal-N	g/m³	< 0.010	0.063	-	-	-
Nitrite-N	g/m³	< 0.0020	0.0031	-	-	-
Nitrate-N	g/m³	3.1	3.1	-	-	-
Nitrate-N + Nitrite-N	g/m³	3.1	3.1	-	-	-
Total Kjeldahl Nitrogen (TKN)	g/m³	0.19	0.27	-	-	-
Dissolved Reactive Phosphorus	g/m³	< 0.0040	< 0.0040	-	-	-
Total Phosphorus	g/m³	0.014	0.018	-	-	-
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)	$g.O_2/m^3$	< 1.0	1.2	-	-	-
Faecal Coliforms	cfu / 100mL	110	250	-	-	-
Escherichia coli	cfu / 100mL	110	250	-	-	-
Enterococci	cfu / 100mL	30	300	-	-	-

Analyst's Comments

The microbiological results may not be a true reflection of the samples at the time of sampling as the samples were greater than 24 hours old on receipt in the lab. Samples must be less than 24 hours old on receipt.

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.

Sample Type: Clean waters

Test	Method Description	Default Detection Limit	Samples
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-2
Total Kjeldahl Digestion	Sulphuric acid digestion with copper sulphate catalyst.	-	1-2
Total Phosphorus Digestion	Acid persulphate digestion.	-	1-2
Turbidity	Analysis using a Hach 2100N, Turbidity meter. APHA 2130 B 21st ed. 2005.	0.050 NTU	1-2

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.

Sample Type: Clean waters			
Test	**Method Description**	**Default Detection Limit**	**Samples**
pH	pH meter. APHA 4500-H^+ B 21st ed. 2005.	0.1 pH Units	1-2
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B 21st ed. 2005.	0.10 mS/m	1-2
Total Suspended Solids	Filtration (GF/C, 1.2µm), Gravimetric. APHA 2540 D 21st ed. 2005	3.0 g/m³	1-2
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N.	0.050 g/m³	1-2
Total Ammoniacal-N	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH_4-N = NH_4+-N + NH_3-N). APHA 4500-NH_3 F (modified from manual analysis) 21st ed. 2005	0.010 g/m³	1-2
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3- I (Proposed) 21st ed. 2005.	0.0020 g/m³	1-2
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - NO2N.	0.0020 g/m³	1-2
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3- I (Proposed) 21st ed. 2005.	0.0020 g/m³	1-2
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} C. (modified) 4500 NH_3 F (modified) 21st ed. 2005.	0.10 g/m³	1-2
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 21st ed. 2005.	0.0040 g/m³	1-2
Total Phosphorus	Total phosphorus digestion, ascorbic acid colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 21st ed. 2005.	0.0040 g/m³	1-2
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, dilutions, seeded. Analysed at; 25 Te Aroha Street, Hamilton. APHA 5210 B 21st ed. 2005.	1.0 g.O_2/m³	1-2
Faecal Coliforms	Membrane Filtration, Count on mFC agar, Incubated at 44.5° C for 22 hours, Confirmation Analysed at Hill Laboratories - Microbiology; 25 Te Aroha Street, Hamilton. APHA 9222 D, 21st ed. 2005.	1 cfu / 100mL	1-2
Escherichia coli	Membrane filtration, Count on mFC agar, Incubated at 44.5° C for 22 hours, MUG Confirmation Analysed at Hill Laboratories - Microbiology; 25 Te Aroha Street, Hamilton. APHA 9222 G, 21st ed. 2005.	1 cfu / 100mL	1-2
Enterococci	Membrane filtration, Count on mE agar, Incubated at 41°C for 48 hours, Confirmation Analysed at Hill Laboratories - Microbiology; 25 Te Aroha Street, Hamilton. APHA 9230 C, 21st ed. 2005.	1 cfu / 100mL	1-2

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.

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

Appendix III

Macroinvertebrate



Macroinvertebrate Sample Results,			Whanga	Whanga	Whanga	Whanga	Whanga
Taxa	MCI	MCI-sb	Site 1	Site 2	Site 4	Site 5	Site 6
	score	score					
Mayfly *Acanthophlebia*	5	9.6					
Mayfly *Ameletopsis*	10	10.0					
Mayfly *Arachnocolus*	8	8.1					
Mayfly *Atalophlebioides*	9	4.4					
Mayfly *Austroclima*	9	6.5					
Mayfly *Austronella*	7	4.7					
Mayfly *Coloburiscus*	9	8.1					
Mayfly *Deleatidium*	8	5.6					
Mayfly *Ichthybotus*	8	9.2					
Mayfly *Isothraulus*	8	7.1					
Mayfly *Mauiulus*	5	4.1	1		1	1	
Mayfly *Neozephlebia*	7	7.6					
Mayfly *Nesameletus*	9	8.6					
Mayfly *Oniscigaster*	10	5.1					
Mayfly *Rallidens*	9	3.9					
Mayfly *Siphlaenigma*	9	9.0					
Mayfly *Tepakia*	8	7.6					
Mayfly *Zephlebia*	7	8.8					
Stonefly *Acroperla*	5	5.1					
Stonefly *Austroperla*	9	8.4					
Stonefly *Cristaperla*	8	8.0					
Stonefly *Megaleptoperla*	9	7.3					
Stonefly *Nesoperla*	5	5.7					
Stonefly *Spaniocerca*	8	8.8					
Stonefly *Stenoperla*	10	9.1					
Stonefly *Taraperla*	7	8.3					
Stonefly *Zelandobius*	5	7.4					
Stonefly *Zelandoperla*	10	8.9					
Caddisfly *Alloecentrella*	9	9.0					
Caddisfly *Aoteapsyche*	4	6.0					
Caddisfly *Beraeoptera*	8	7.0					
Caddisfly *Confluens*	5	7.2					
Caddisfly *Costachorema*	7	7.2					
Caddisfly Ecnomidae	8	7.0					
Caddisfly *Edpercivalia*	9	6.3					
Caddisfly *Helicopsyche*	10	8.6					
Caddisfly *Hudsonema*	6	6.5					
Caddisfly *Hydrobiosella*	9	7.6					
Caddisfly *Hydrobiosis*	5	6.7			2	2	
Caddisfly *Hydrochorema*	9	9.0					
Caddisfly *Kokiria*	9	9.0					
Caddisfly *Neurochorema*	6	6.0					
Caddisfly *Oecetis*	4	6.8					
Caddisfly Oeconesidae	9	6.4					
Caddisfly *Olinga*	9	7.9					
Caddisfly *Orthopsyche*	9	7.5					
Caddisfly *Oxyethira*	2	1.2	2		2	2	3
Caddisfly *Paroxyethira*	2	3.7					

Caddisfly *Philorheithrus*	**8**	**5.3**					
Caddisfly *Plectrocnemia*	**8**	**6.6**					
Caddisfly *Polyplectropus*	**8**	**8.1**					
Caddisfly *Psilochorema*	**8**	**7.8**					
Caddisfly *Pycnocentrella*	**9**	**9.0**					
Caddisfly *Pycnocentria*	**7**	**6.8**					
Caddisfly *Pycnocentrodes*	**5**	**3.8**			1		
Caddisfly *Tiphobiosis*	**6**	**9.3**					
Caddisfly *Triplectides*	**5**	**5.7**					
Caddisfly *Zelolessica*	**10**	**6.5**					
Damselfly *Austrolestes*	**6**	**0.7**					
Damselfly *Ischnura*	**6**	**3.1**					
Damselfly *Xanthocnemis*	**5**	**1.2**					
Dragonfly Aeshnidae	**5**	**1.4**					
Dragonfly *Antipodochlora*	**6**	**6.3**					
Dragonfly *Hemicordulia*	**5**	**0.4**					
Dragonfly *Procordulia*	**6**	**3.8**					
Bug *Anisops*	**5**	**2.2**					
Bug *Diaprepocoris*	**5**	**4.7**					
Bug *Mesovelia*	**5**	**5.0**					
Bug *Microvelia*	**5**	**4.6**					10
Bug Saldidae	**5**	**3.9**					
Bug *Sigara*	**5**	**2.4**					
Dobsonfly *Archichauliodes*	**7**	**7.3**					
Scorpionfly *Nannochorista*	**7**	**7.0**					
Lacewing *Kempynus*	**5**	**5.0**					
Lacewing *Sisyra*	**5**	**5.0**					
Beetle *Antiporus*	**5**	**3.5**					
Beetle *Berosus*	**5**	**5.0**					
Beetle Dytiscidae	**5**	**0.4**					
Beetle Elmidae	**6**	**7.2**					
Beetle Hydraenidae	**8**	**6.7**					
Beetle Hydrophilidae	**5**	**8.0**					
Beetle *Liodessus*	**5**	**4.9**					
Beetle Ptilodactylidae	**8**	**7.1**		1			
Beetle *Rhantus*	**5**	**1.0**					
Beetle Scirtidae	**8**	**6.4**					
Beetle Staphylinidae	**5**	**6.2**					
True Fly *Aphrophila*	**5**	**5.6**					
True Fly *Austrosimulium*	**3**	**3.9**		1	3	1	
True Fly Blephariceridae	**7**	**7.0**					
True Fly Ceratopogonidae	**3**	**6.2**					
True Fly *Chironomus*	**1**	**3.4**					
True Fly *Corynoneura*	**2**	**1.7**					
True Fly Culicidae	**3**	**1.2**					
True Fly Dolichopididae	**3**	**8.6**					
True Fly Empididae	**3**	**5.4**					
True Fly Ephydridae	**4**	**1.4**					
True Fly Eriopterini	**9**	**7.5**					
True Fly *Harrisius*	**6**	**4.7**					
True Fly Hexatomini	**5**	**6.7**			1		
True Fly *Limonia*	**6**	**6.3**		2			

True Fly *Lobodiamesa*	**5**	**7.7**					
True Fly *Maoridiamesa*	**3**	**4.9**					
True Fly *Mischoderus*	**4**	**5.9**					
True Fly *Molophilus*	**5**	**6.3**					
True Fly Muscidae	**3**	**1.6**					
True Fly *Nothodixa*	**5**	**9.3**					
True Fly Orthocladiinae	**2**	**3.2**		3			
True Fly *Paradixa*	**4**	**8.5**					
True Fly *Paralimnophila*	**6**	**7.4**					
True Fly Pelecorhynchidae	**9**	**9.0**					
True Fly Podominae	**8**	**6.4**					
True Fly *Polypedilum*	**3**	**8.0**					
True Fly Psychodidae	**1**	**6.1**					
True Fly Sciomyzidae	**3**	**3.0**					
True Fly *Stictocladius*	**8**	**8.0**					
True Fly Stratiomyidae	**5**	**4.2**					
True Fly Syrphidae	**1**	**1.6**					
True Fly Tabanidae	**3**	**6.8**					
True Fly Tanypodinae	**5**	**6.5**	1	7		7	
True Fly Tanytarsini	**3**	**4.5**					
True Fly Thaumaleidae	**9**	**8.8**					
True Fly *Zelandotipula*	**6**	**7.0**					
Moth *Hygraula*	**4**	**1.3**					
Collembola	**6**	**5.3**					
Crustacea Cladocera	**5**	**0.7**					
Crustacea Copepoda	**5**	**2.4**					
Crustacea *Halicarcinus* crabs	**3**	**5.1**					
Crustacea *Helice* crabs	**3**	**6.6**					
Crustacea Isopoda	**5**	**4.5**					
Crustacea Mysid shrimps	**5**	**6.4**					
Crustacea Ostracoda	**3**	**1.9**					
Crustacea *Paracalliope*	**5**	**5.0**					
Crustacea *Paraleptamphopus*	**5**	**5.0**					
Crustacea *Paranephrops*	**5**	**8.4**					
Crustacea *Paranthura*	**5**	**4.9**					
Crustacea *Paratya*	**5**	**3.6**	23	7	5	20	33
Crustacea *Phreatogammarus*	**5**	**5.0**					
Crustacea Talitridae	**5**	**5.0**					
Crustacea Tanaidacea	**4**	**6.8**					
MITES	**5**	**5.2**					
SPIDERS *Dolomedes*	**5**	**6.2**					
TARDIGRADES	**4.5**	**4.5**					
Mollusc *Ferrissia*	**3**	**2.4**					
Mollusc *Glyptophysa*	**5**	**0.3**					
Mollusc *Gyraulus*	**3**	**1.7**					
Mollusc *Hyridella*	**3**	**6.7**					
Mollusc *Latia*	**3**	**6.1**					
Mollusc Lymnaeidae	**3**	**1.2**					
Mollusc *Melanopsis*	**3**	**1.9**					
Mollusc *Physella*	**3**	**0.1**					
Mollusc *Potamopyrgus*	**4**	**2.1**	132	159	111	120	168
Mollusc Sphaeriidae	**3**	**2.9**		11	1		

OLIGOCHAETES	1	3.8					
LEECHES	3	1.2					
PADDLEWORMS	3	6.7					
FLATWORMS	3	0.9					
Rhabdocoel Flatworms	3	0.9					
NEMATODES	3	3.1					
NEMERTEANS	3	1.8					
NEMATOMORPHS	3	4.3					
HYDROIDS	3	1.6					
BRYOZOA	4	4.0					