STAFF REPORT

TO:	Environment & Planning Committee
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REFERENCE:	H505, S750
SUBJECT:	**IMPACT OF DISCHARGES FROM STORMWATER SYSTEMS ON STREAMS AND ESTUARY MARGINS IN RICHMOND: 2010 REPORT - REPORT REP10-07-07 -** Report prepared for meeting of 1 July 2010

EXECUTIVE SUMMARY

- In November 2009 and January 2010 sediments from nine waterways near Richmond were assessed for heavy metals and polyaromatic hydrocarbons (PAH), against the ANZECC sediment guidelines. This investigation included sediment sampling at the estuarine sites sampled in 1996 and 2004, and also at sites upstream and downstream of residential, commercial and industrial areas on Jimmy-Lee and Borck Creeks.

- Water samples were collected from a number of sites on Jimmy-Lee and Borck Creeks during a rainfall event on 24 March 2010 after a two-week dry spell. Samples were analysed for faecal bacteria, heavy metals, PAH, petroleum hydrocarbons, for benzene, toluene, ethylbenzene, and xylene (BTEX) and a range of other volatile and semi-volatile organic compounds.

- Sediment results: Moderately high concentrations of zinc in sediment were found at most sites downstream of residential, commercial and industrial catchments. The sediments impacted by run-off from industrial sites had some additional heavy metal and PAH contaminants. The mainly-rural catchments were satisfactory.

- Most estuary sediment samples were less contaminated than the streams contributing to them, indicating dilution in the estuary. In comparison with a similar estuary sediment investigation five years ago, there is a trend for general reduction of contaminants in the estuary sediments, except for zinc which is increasing. The association of zinc with roads and vehicle density is well-known and records show considerable growth in transport density.

- The ANZECC sediment quality guidelines were exceeded by some commercial and industrial catchments, indicating potential for an adverse impact on the aquatic life in the streams and estuary.

- Stormwater results: Water samples from Jimmy-Lee Creek were slightly above guidelines for the heavy metals aluminium, copper and zinc at all sites (including upstream reference site). Aluminium and zinc increased 2-3 times between the residential and industrial areas. No other metals were of concern. No volatile or semi-volatile organic compounds such as poly aromatic hydrocarbons or pesticides were of concern (all were below detection levels).

- Faecal bacteria in Jimmy-Lee Creek were elevated at upstream of Hill Street, possibly due to dog faeces deposited near a popular track that follows the stream or incorrect connection or leak to/from the sewerage system. Faecal bacteria concentrations more than doubled through Washbourne Gardens and a widened pond in Stillwater Creek, probably due to large numbers of ducks in these ponded areas.

- The ecological condition of the lower part of Jimmy-Lee Creek is very poor compared to the upper part (upstream Hill Street). The dominant macro-invertebrates were worms and true flies, and no mayflies, stoneflies or caddisflies were found in either the Washbourne Gardens or the Beach Road sites. Fish surveys have not been undertaken on Jimmy-Lee Creek, but reasonably high numbers of inanga and eels were found in Borck Creek right up to Wensley Road.

- The information will be a useful contribution to the Assessment of Environmental Effects when the engineering department applies for resource consent for discharge from the Richmond stormwater network. Further work is required by Council and the industries in Richmond, to ensure compliance with Council's hazardous facility Rule 17.3 and stormwater Rule 36.

1. INTRODUCTION

The main purpose of this study was to assess the levels of persistent contaminants in stormwater, stream water, stream sediment and/or estuarine sediments from nine waterways in or near Richmond. This is the first time that water quality has been sampled in these waterways but for sediments at the mouth of these waterways results could be compared with two previous studies in 1996 and 2004. This information enables Council to identify areas or sources of contamination that can be assessed for compliance with Council's rules.

In addition to sediment sampling sites used in 1996 and 2004, seven sites in the catchments upstream of the estuarine sites were sampled to provide information on the natural background levels as well as the effect of residential and commercial land uses and industrial discharges on sediment quality.

Persistent contaminants such as heavy metals (cadmium, chromium, zinc) and polyaromatic hydrocarbons (PAHs) commonly arise from vehicle emissions, tyres wearing on roads and waste oil as well as discharges from particular industrial premises such as transport yards, vehicle workshops, cement batching, asphalt production and timber treatment. These contaminants generally bind tightly to soil or sediment and can be washed by rain into the stormwater system and finally become deposited in the estuary. All these contaminants are persistent (i.e. do not break down, or do so very slowly) and are potentially toxic to the flora and fauna of streams and estuaries.

Upper estuaries are particularly vulnerable to effects from contaminated sediments because the sediment is retained and accumulates with minimal exposure to tidal flushing.

The first flush after a dry spell is well known to produce the worst quality compared to any other time.

2. METHODS

2.1 Sediments

Nine waterways that enter the estuary near Richmond were investigated. These have a variety of land uses in their catchments from rural, residential, commercial, and industrial land, and some with a mixture. See Table 1 below. These nine waterways had all been sampled in 2004. Four of these waterways; Reservoir Creek, Vercoes Drain, Jimmy-Lee Creek (also known as Beach Road Drain in the lower section) and Racecourse Stream, were sampled for the same contaminants in their estuarine sediments in 1996, enabling a limited comparison over those thirteen years. However, given that there are only two samples for each site at each sampling event, and the observed variability in the sampling results, the trends over time and between sites should be regarded as an indication only.

The waterways chosen are listed in Table 1.

Table 1: Waterways Sampled

Waterway	Catchment Land Use	1996	2004	2009
Reservoir Creek Mouth	Residential	√	√	√
Sicon Drain *(unnamed)**	Industrial and commercial	x	√	√
Vercoes Drain*	Industrial, commercial and residential	√	√	√
Jimmy-Lee Creek at end of Beach Road Drain*	Industrial, residential and rural	√	√	√
Northern Refuse Transfer Station Drain* *(unnamed)*	Industrial and rural	x	√	√
Racecourse Creek *(unnamed)*	Rural and industrial	√	√	√
Borck Creek	Rural,residential and industrial	x	√	√
Dynea Drain culvert *(unnamed)**	Industrial	x	√	√
NPI Drain culvert *(unnamed)* *	Rural (piped under industrial)	x	√	√

* “Drains” have been piped or straightened for much of their length.

For this study the unnamed waterways have been named after the locations where they enter the estuary.

Finer sediments, such as soft muds, silts or sands were selected for sampling, rather than gravels or cobbles as it is the finer sediments that contain the persistent contaminants of interest. As far as possible, samples were collected with a similar sediment size distribution. These sediments were collected from beside or within the active wetted waterway channel representing relatively recent deposition.

For each sediment sample the following information was recorded: location (GPS), photo, sediment colour and sediment type.

Estuary Sediment Samples

Estuary sediment cores were sampled using a 150mm diameter stainless-steel corer to a depth of 150 millimetres (mm) as this is the zone used by most mud-burrowing organisms. Two samples were taken from all sites, except for one small drain.

This 2009 study included taking a top 0-30mm sample as well as a representative sample of the whole depth (0-150mm), enabling a separate comparison to be made between the recently-deposited top sample and the "average over the whole depth" which was used for the previous 1996 and 2004 sampling rounds.

The field record included the type of mud, sediment or cobbles, whether part or all of the sediment core was dark and anoxic, and whether it had a sulphurous odour. The core was photographed, and the sampling locations (GPS) recorded. These field notes are in Appendix A.

Freshwater Sediment Samples

These samples were taken in late January 2010, after the results were back from November 2009 estuary samples and a comparison could be made between the "top" and "total" estuary samples. Generally there was not a significant difference and it was decided to take only shallow samples (0-30mm) from the creek beds, and take a number of subsamples to get a representative sample from the area.

2.2 Water Quality

Grab samples were collected in lab-prescribed and supplied bottles from well-mixed mid-stream sites during storm events on 17 December 2009 (faecal bacteria only), 24 March, 2010 and 13 April 2010 (a road-side gutter site only).

Samples were analysed for persistent contaminants including metals (total, not soluble), volatile organic compounds (VOC's) and semi-volatile organic compounds (SVOC's). Samples were taken at four sites on Jimmy-Lee Creek and one site on Borck Creek. Sites for faecal bacteria sampling included the above sites as well as sites on Upper Borck Creek (a tributary of Eastern Hills Drain) and Reservoir Creek and its tributary Stillwater Creek.

On 24 March two samples were taken from the most downstream site on Jimmy-Lee Creek (64 Beach Road). The first was after a band of about 6mm of moderately intensive rain and the second about 5.5 hours later after another 6.5 mm of moderately intense rainfall. Between each of these bands of rain the rain ceased for about 2-3 hours. Rainfall prior to sampling is shown on Figure 1. The rainfall events earlier in March were not intense (more drizzly), which is why samples were not taken then.

The sample of road run-off was taken from Gladstone Road because it has the highest traffic flows in Richmond (annual average daily traffic volume of 18,000-19,000), including a high percentage of heavy vehicles, and this is an area where vehicles break as they approach the traffic lights at Queen Street.

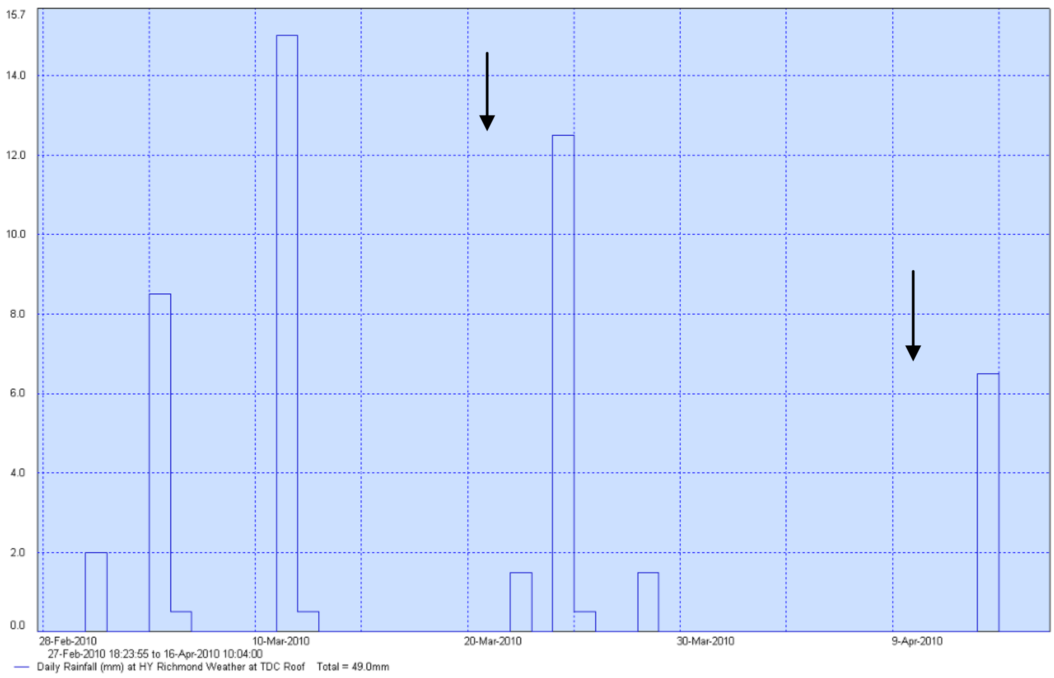


Figure 1: Rainfall records at Richmond (Council Offices) prior to stormwater sampling. Arrows indicate sampling events.

Sample analysis was undertaken at IANZ accredited laboratories: Cawthron for metals and faecal bacteria and Hill Labs for VOC's and SVOC's.

A multi-parameter water quality meter (YSI 6920 datasonde) was installed in Jimmy-Lee Creek just downstream of Hill Street (the upstream site was not secure because of visibility to the public). Another such meter was installed at 64 Beach Road but unfortunately the data was lost.

Macro-invertebrates were sampled by kick net in a stable flow period in December, 2009 at three sites on Jimmy Lee Creek (upstream Hill Street, Washbourne Gardens and 35 Beach Road) and one site on Borck Creek.

3. DATA ANALYSIS

Contaminant concentration data in sediments and water were compared to the ANZECC Guidelines 2000.

For sediment, there are two values given for each contaminant, based on research with a variety of organisms and animals that live in the estuary or freshwater streams, observing the non-lethal and lethal effects from different contaminants. ISQG "low", at or below which these adverse effects would rarely be observed, and ISQG "high", where adverse effects occur frequently. In between these two values there is likely to be occasional adverse effects.

Ideally the sediments in the estuary and natural streams should comply with "low" Guideline values for all contaminants, and "high" values indicate the contaminants are at unacceptable concentrations for this type of environment.

For waters, there are four levels of protection listed for each contaminant depending on the level of protection required in the waterway (99%, 95%, 90% and 80%). In this case results were compared to guidelines that protect 90% of species. It could be argued that the 80% level of protection is more appropriate for Jimmy-Lee Creek given its high degree of modification and piping for over 1 km of its length. However, without a more complete assessment of values in this waterway, this cannot be determined.

4. RESULTS

4.1 Sediment

Sediment sampling results are summarised on Figure 2.

4.1.1 Heavy Metals

See Appendix A1 and A2

The high levels of nickel and chromium are due mainly to the sediments being derived from the natural, parent, ultramafic rock in the eastern hills behind Nelson. Some of the industries could have contributed to these levels, but it is not possible to quantify this contribution unless each stormwater discharge was monitored. These two metals are not included in the discussions of contaminants.

4.1.2 Polyaromatic Hydrocarbons (PAHs)

See Appendix A4 and A5

The results in these tables come from summing the six individual polyaromatic hydrocarbons that are described as low molecular weight (up to 3 aromatic rings), and the six <u>different</u> individual polyaromatic hydrocarbons that are described as high molecular weight. The total PAH includes other individual PAH included in the laboratory analysis because they are part of the 16 PAH compounds which are USEPA priority pollutants. The values that were below detection have not been included in the summation. The complete laboratory reports are available on request.

4.1.3 Trend over the study period: 1996, 2004 and 2009

This comparison is limited to the four waterways sampled in 1996, and for the four heavy metals and total PAHs which exceeded the “low” ISQG Sediment criteria. See Fig 1 in Section 5 below.

4.1.4 Tributyltin - Results and Discussion

Vercoes Drain has been subjected to tributyltin (TBT) contamination from the stormwater discharge from a timber treating yard in Richmond. TBT is very ecotoxic to estuarine organisms hence the very low sediment Guideline values. The organic tin compound TBT breaks down to dibutyltin (DBT) and then to monobutyltin (MBT), and this is reflected in the ratios between the upper reaches of the Drain, and the mouth. The “high” guideline value is permitted inside the boxed culvert of the

Vercoes Drain, and in the channel, including the 2009 channel site, and the "low" is for the mouth, once it has entered the sensitive ecosystem in the estuary.

The 1996, 2004 and 2009 results are shown below in Table 2.

Table 2: Tributyltin in Vercoes Drain, 1996, 2004 and 2009

Location	**Contaminant**	**ISQG Low**	**ISQG High**	**1996**	**2004**	**2009 Top**	**2009 Total**
Vercoes Drain, upper	TBT	0.005	0.07	**0.285***	**0.084***		
	DBT			0.118	0.046		
	MBT			ND	0.041		
Vercoes Drain, mouth	TBT	0.005	0.07	**0.048**	**0.10**	<0.008	<0.008
	DBT			0.038	0.017	0.011	<0.010
	MBT			0.007	ND	<0.010	<0.010

Note: "Low" and "high" refer to the ANZECC 2000 Interim Sediment Quality Guidelines - those values exceeding low are **bold** and those exceeding high are **bold***

In 2009 the Upper Vercoes Drain site was not sampled for TBT. However, in addition to the sample taken at the Vercoes Drain mouth, a sediment sample was taken 15m up from the mouth, in the centre of the slow flowing channel. The results are presented in Table 3 below:

Table 3: Tributyltin in Vercoes Drain lower channel, 2009

Location	**Contaminant mg/kg/dry wt**	**ISQG high**	**Top**	**Total**
Vercoes Drain lower channel	TBT	0.07	0.015	0.039
	DBT		0.013	0.020
	MBT		<0.010	<0.010

The "top" and "total" samples at this sample site indicate that the concentration of TBT is less in the recently deposited surface (top) sediment. This reduction could be from the reduced concentrations of TBT in the sediment, or the chemical breakdown in sun light and water. As mentioned above these higher concentrations comply with the requirement for the sediments inside the Drain - before they reach the estuary.

4.2 Contaminants in Stormwater

4.2.1 Suspended Solids

Total suspended solids results were relatively low in all samples other than Borck Creek where a discharge from a concrete product plant occurred upstream 180 g/m^3. Results for Jimmy-Lee Creek ranged from 10 g/m^3 at Hill Street to 66 g/m^3 and 34 g/m^3 at 35 and 64 Beach Road respectively.

4.2.2 Heavy Metals

Water samples from Jimmy-Lee Creek were slightly above ANZECC guidelines (90% level of ecosystem protection) for the heavy metals aluminium, copper and zinc at all sites, including the upstream reference site (see Figure 3). These metals are also the most soluble of the metals tested. However, when compared to guidelines for 80% level of ecosystem protection all these metals were at acceptable concentrations. Aluminium and zinc increased 2-3 times between the residential area (Washbourne Gardens) and industrial area (top end of Beach Road Drain). The concentrations of all other heavy metals were below detection levels and guidelines (for 90% protection) in the stream samples. Lead and nickel were above the guidelines in the road run-off sample.

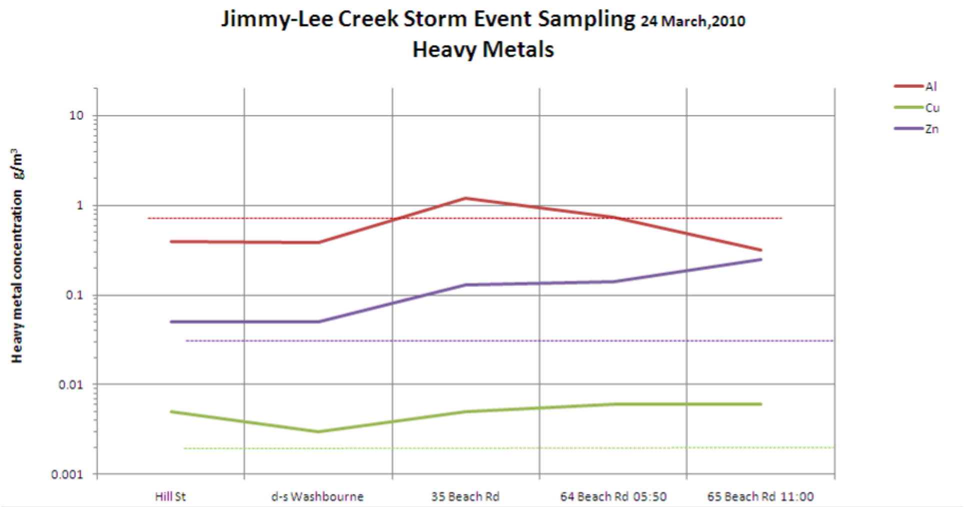


Figure 3 Selected heavy metal concentrations (total, not soluble) from water samples from Jimmy-Lee Creek on 24 March, 2010. Dashed lines are the ANZECC guideline value for 90% level of protection; the colour of the dashed line relating to the specific metal identified by colour in the legend. Note: the scale is logarithmic (Base 10) and the lines appear flatter than for a normal scale.

Copper and chromium concentrations in Borck Creek at the Railway Reserve are almost 10x and 14x higher than Jimmy-Lee Creek respectively (and ~23x and 7.3x the guidelines for 90% protection respectively) downstream of a yard storing timber treated with copper-chrome-arsenic. It is likely that this yard is a significant contributor to this situation. Aluminium, cadmium and lead were also above this guideline with only aluminium being significantly above. This site on Borck Creek is also the only site sampled where arsenic and cadmium was above detection.

4.2.3 Volatile and semi-volatile organic compounds

The screen of 148 of the most toxic volatile or semi-volatile organic compounds in water samples from four sites on Jimmy-Lee, road gutter and Borck Creek showed none above detection levels. Chemicals tested for included: polyaromatic hydrocarbons (including benzo-α-pyrene, nathalene), organochlorine pesticides, halogenated aromatics, plasticisers, petroleum hydrocarbons and BTEX.

4.2.4 Disease-Causing Organisms

Faecal bacteria in Jimmy-Lee Creek were elevated at the upstream reference site (upstream Hill Street) and generally decreased downstream with the exception of a spike from a source in Washbourne Gardens where *E.coli* concentrations more than doubled (see Figure 4a).

E.coli concentrations in Reservoir Creek at Easby Park (upstream Marlborough Cres) were similar to that in Jimmy-Lee Creek on 24/03/2010. A sample taken upstream of the Reservoir on 17/12/09 showed much lower concentrations (at detection).

E.coli concentrations in Borck Creek ranged from 290-375 *E.coli*/100ml at all sites from Hill Street to the mouth on 17 December, 2010.

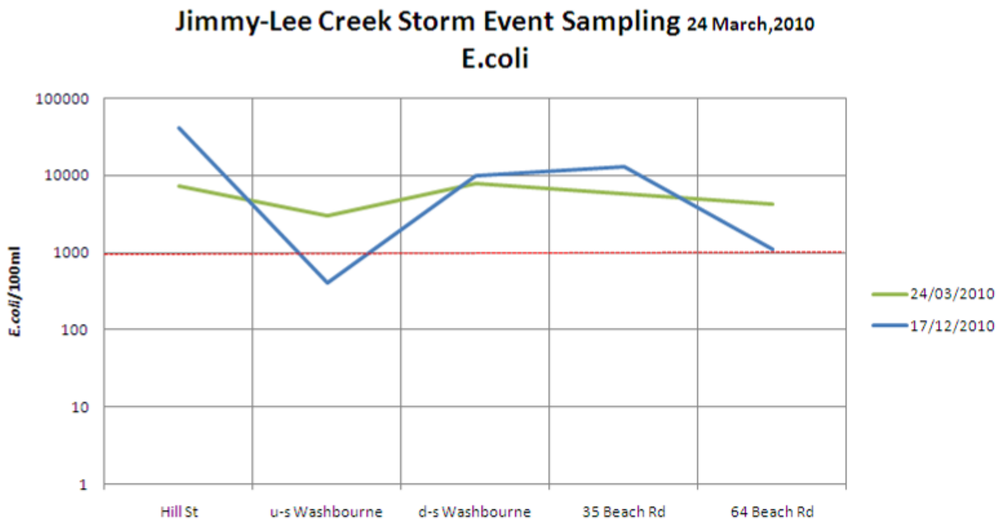


Figure 4a: *E.coli* concentrations on a longitudinal transect on Jimmy-Lee Creek during two separate stormwater events. The dashed red line is the stock drinking water guidelines (ANECC 2000). Note: the scale is logarithmic (base 10) and the lines appear flatter than for a normal scale.

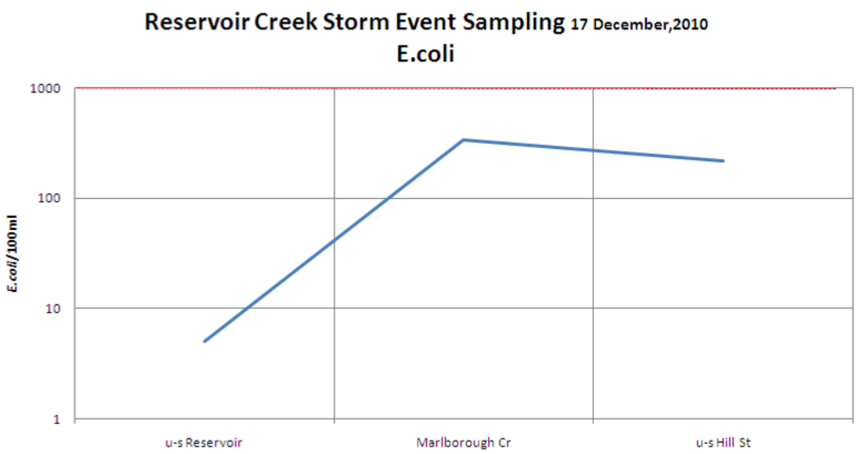


Figure 4b: *E.coli* concentrations on a longitudinal transect on Reservoir Creek during a stormwater event on 17 December, 2009. The dashed red line is the stock drinking water guidelines (ANECC 2000). Note: the scale is logarithmic (base 10)

4.2.5 Compliance Issues

While sampling during the March storm event two particularly conspicuous discharges from industrial areas were evident. One discharge was moderately alkaline bright, white-coloured appeared to originate from a cement fabricator on Gladstone Road discharging to Borck Creek (see Figure 5a). The other discharge was a petroleum slick from a coolstore on Beach Road to Jimmy-Lee Creek. Both these discharges were followed up by Council's compliance team (see Figure 5b).

Figure 5a Discharge to Borck Creek downstream Gladstone Road on the Railway Reserve

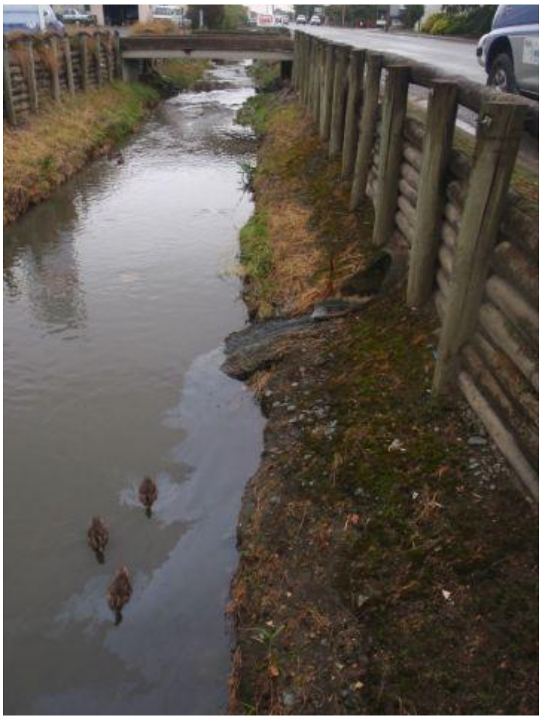


Figure 5b Petroleum sheen from a discharge near 64 Beach Road

4.3 Ecological Condition

The middle and lower part (downstream Washbourne Drive and along Beach Road respectively) of Jimmy-Lee Creek had very poor macro-invertebrate condition compared to the upper part (upstream Hill Street)(see Figure 6). The habitat at the Washbourne Gardens was characterised by a high fine-sediment load and high turbidity.

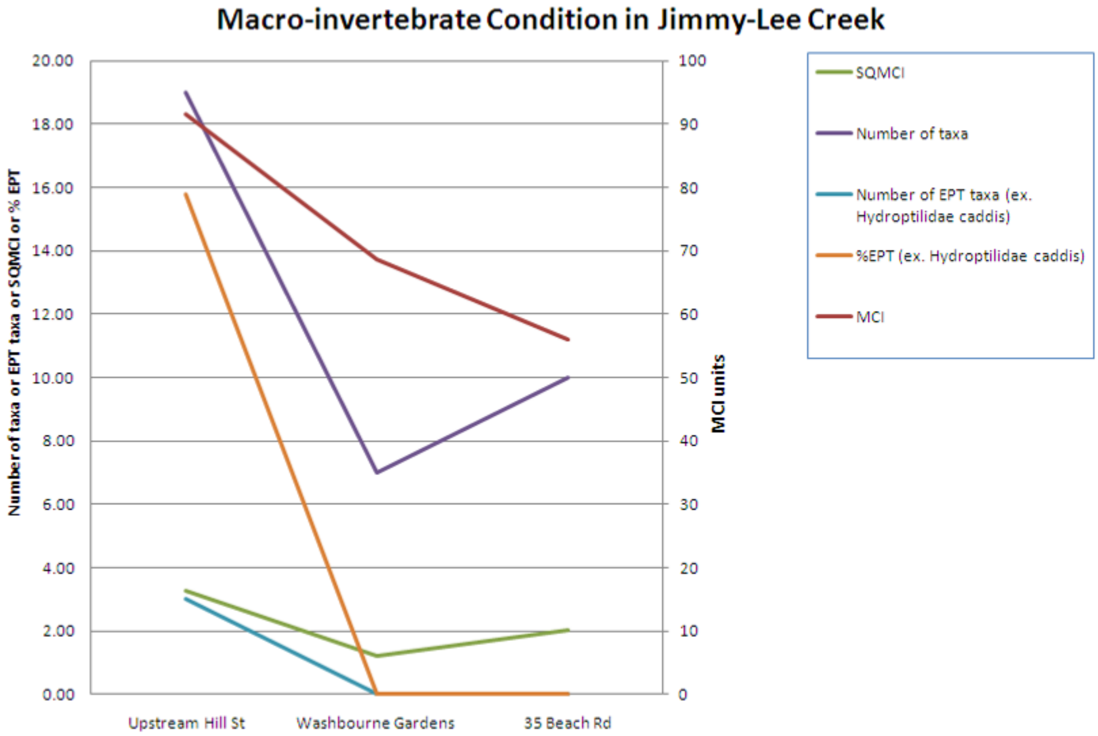


Figure 6 Five metrics of macro-invertebrate condition along a longitudinal transect of Jimmy-Lee Creek.

Fish surveys have not been undertaken on Jimmy-Lee Creek, but reasonably high numbers of inanga and eels were found in Borck Creek from the mouth right up to Wensley Road and smelt and shrimp also common in the lower part. There are records of banded kokopu in the upper reaches of Jimmy-Lee Creek. So it is expected that, where good habitat is present like above Hill Street, we would expect to native fish to occupy the waterway, barring any fish passage issues.

5. DISCUSSION

5.1 Estuary Sediments

5.1.1 2009 Results

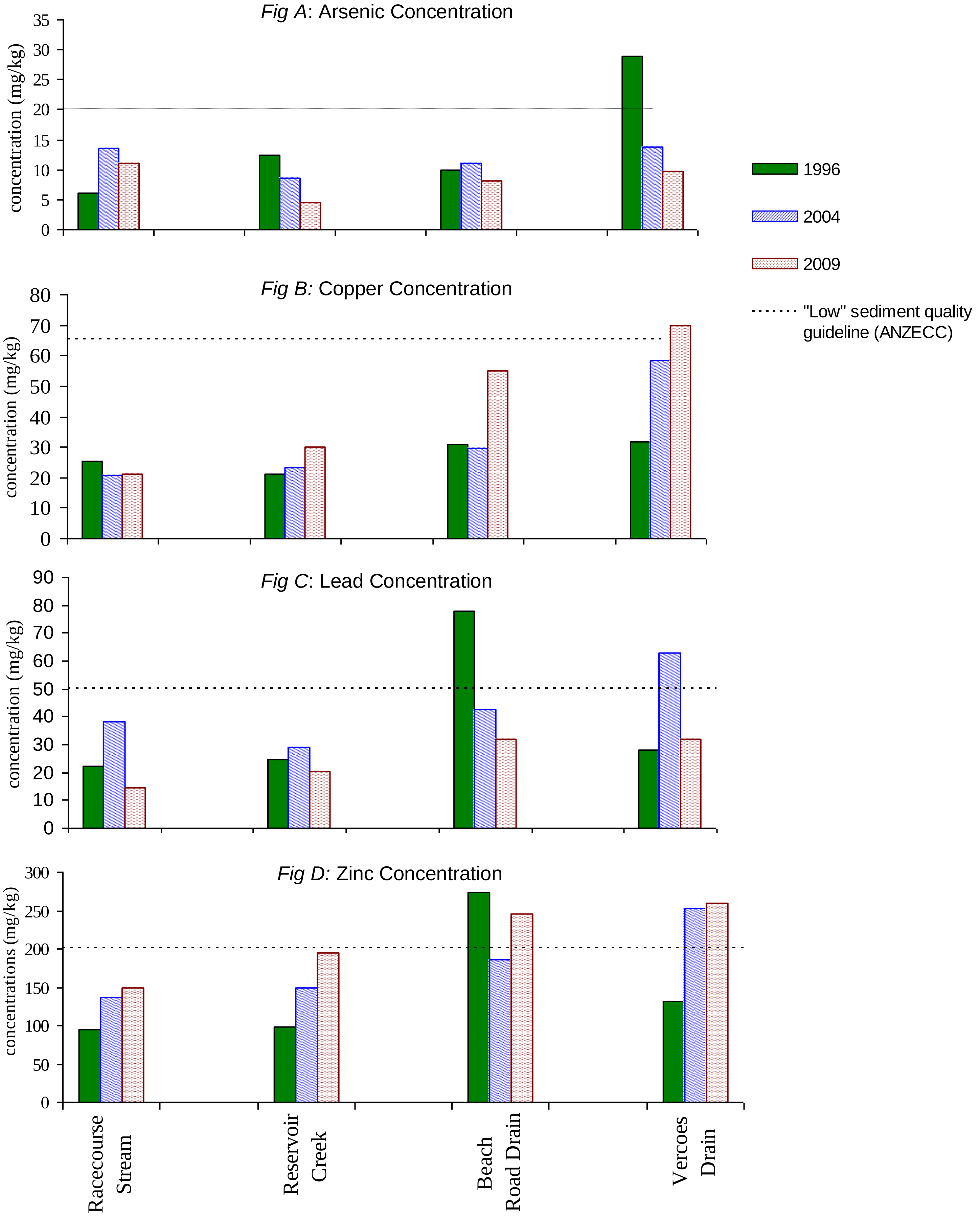
Sediments in the estuaries near the mouths of five waterways with mainly urban or rural catchments (i.e. Reservoir Ck., Racecourse Ck., Borck Ck, the NPI culvert and suprisingly the Sicon Drain) all comply with the heavy metal and PAH sediment guideline criteria.

The estuary bordering the waterways from four industrial catchments exceed the zinc guideline criteria and two of them also exceed the PAH guidelines. These sites are Beach Road, Vercoes Drain, the Drain north of RTS and the Dynea culvert.

5.1.2 Trends Since 1996

There are only four sites that have been sampled in 1996, 2004 and 2009, and the results for four heavy metals are plotted in Figure 7. This provides a graphic comparison between the residential stream Reservoir Creek, and the commercial and industrial Beach Road and Vercoe Drains.

Fig7: Selected heavy metal concentrations in sediments at four locations 1996-2009



5.1.2.1 Arsenic

It can be seen in Figure 7(A) there is a marked decline in Vercoes Drain where the closure of a tanalising timber treatment facility has removed that source of arsenic. There is a slight reduction in the residential Reservoir creek, and the reason is not known.

5.1.2.2 Copper

Since 1996 copper has increased in the two industrial catchments, but the sources are not known. Figure 7(B). The timber treatment plant would have been contributing less over time (as for arsenic) but another industry may be discharging more.

5.1.2.3 Lead

Figure 7(C) shows a marked reduction in lead from the two industrial Drains.

5.1.2.4 Zinc

There is an increasing trend for zinc concentrations since 1996 (see Figure 7(D) in urban catchments, presumably from vehicle brake linings and emissions, and this reflects the increase in traffic density in Richmond. The pattern with Beach Road may reflect the higher usage of a transport yard and vehicle washes going to stormwater in 1996. The sediments from mainly rural catchments Racecourse stream, Borck creek, and NPI culvert had complying concentrations of zinc, see Appendix A3.

5.1.3 Dynea Culvert

The Dynea drain culvert sediments had extremely high concentrations of zinc exceeding the guideline value for an industrially impacted stream, with the top 0-30mm samples being significantly higher than the total 0-150mm, but both exceeding the guidelines. The concentrations of cadmium also exceeded estuary guideline values.

The Dynea Creek culvert is named because of the position of its outlet, but the Dynea industrial site does not discharge into this piped stormwater system, and the area that does has been used by the Nelson Pine Industry since 2002. The land is now covered by very extensive buildings with only a small area of sealed yard. The 2004 concentrations of zinc and cadmium from the Dynea culvert sediments were elevated but compliant with estuary guidelines. But now, five years later the accumulation of these heavy metals is marked. After discussions with the management at NPI they carried out onsite tests of the stormwater sumps and have confirmed that it is from the roof. The current theory is that although the roof surface itself is coated steel, when holes were drilled for the fastenings the filing debris containing zinc and cadmium have accumulated in the stormwater system. They have undertaken to clean out the sediment from the sumps and water blast the stormwater pipes and dispose of the sediments as waste. They will continue to monitor and collect the sediment until the problems are resolved.

5.1.4 Northern Refuse Transfer Station Drain

This site beside the Refuse Transfer Station (RTS) shows an improvement from 2004, and this is probably due to the improved management of the Councils RTS, which is one of the three contributing sources of stormwater. The zinc concentration is high, and this site had the highest concentration of lead from all the sample sites, but is still compliant.

5.1.5 Racecourse Stream

All samples were compliant. Of note is an increase in zinc each year. This stream is approximately 0.65km in length, and receives some industrial stormwater, including possible leachate from the commercial composting area on top of a closed hardfill which started after 1996. It also travels through the rural A&P showgrounds.

5.1.6 Difference Between "top" and "total" Estuary Samples

The difference between the top 30mm and the total (or whole) 150mm of sediment sample does not appear to be significantly different in most locations and for most heavy metals contaminants (except for Dynea culvert mentioned above). The PAH samples have more variability in them than the metals, indicating that the PAH comes from discrete incidents rather than a steady flow.

This indicates that the recently-deposited estuary sediment was similar in concentrations of heavy metals and PAHs to the previous years. Council has sediment deposition plates in the Waimea estuary off the Richmond Transfer Station Borck Creek and Resevoir Creek. From September 2008 to Feb 2010 there was very little change in the average deposition rate.

5.2 Upstream Sediments

See Appendix A3 and A5

5.2.1 Jimmy Lee Creek

5.2.1.1 Zinc

The concentrations of zinc Jimmy Lee Creek as it travels through the Beach Road Drain are extremely high. (see Appendix A3). It had already exceeded "low" sediment guidelines at the Washbourne gardens but at the top of the stretch down Beach Road it exceeds the "high" sediment guidelines applicable to impacted industrial drains, and halfway down, after the McPherson Street bridge it is almost double that guideline.

The estuary sediment sample 65m into the estuary has been diluted by cleaner deposits, but it still exceeds the safe limit for marine organisms (i.e. "low" guideline) by 50%. Zinc is a metal and because it does not breakdown it will accumulate in the receiving environment.

Another way of describing the increase is to start with the original zinc concentration before roads (at Hill Street) and note that 1km downstream it is 100mg/kg more, 1.8km it is 300mg/kg more, and 2.3km it is 600mg/kg more. That last value is 5x more than what it started with at Hills Street. There are other tributaries of the Jimmy Lee and they all enter the estuary through the Beach Road Drain.

5.2.1.2 Lead and Crome

Lead similarly increases four-fold from the pre traffic site at Hill Street to halfway down Beach Road Drain, with chrome increasing two fold.

5.2.2 Borck Creek

Borck Creek at the Railway Reserve bridge has been contaminated by the upstream discharge of stormwater from a premise storing treated timber posts in the open. The concentrations of copper, chrome and arsenic all exceed the "low" sediment quality guidelines, and so does zinc at this point. Some 3.75km further on near the mouth of the Borck Creek the sediments comply, having been diluted with cleaner sediments. Council is following up with this retail treated timber yard.

5.2.3 Vercoes Drain

The sample of sediment from the boxed culvert has high concentrations of all the heavy metals (except cadmium), and the three types of PAHs. Vercoes Drain also receives stormwater from Richmond township as well as industrial. It is not clear why the contamination is so high. The drain is 200m long, tidal and has accumulated soft sediments.

5.2.4 NPI Upstream Sample

The drain sampled on the roadside across from Dynea culvert actually discharges through the NPI culverts, along with other stormwater from other rural areas. The sediment has low zinc, copper and lead, similar to the pre-traffic Hill Street sample from Jimmy Lee Creek.

6. CONTAMINANTS IN WATER

6.1 Persistent Contaminants

The stormwater not only carries sediment-bound contaminants but also contaminants in soluble (dissolved) form. Those contaminants that are particularly soluble include the aluminium, copper, and zinc as well as many of the organic compounds including the lower molecular weight PAHs. In this study the total sample was analysed, which includes any sediment-bound contaminants in the sample.

6.1.1 Metals

The pattern of increasing copper concentration downstream on Jimmy-Lee Creek followed a similar pattern in the sediment samples, particularly with respect the increase between Washbourne Gardens and upper part of Beach Road.

There was a relatively consistent concentration of metals at the most downstream site on Jimmy-Lee Creek. While variabile in stormwater sample result this gives some indication that we have a typical result.

Concentrations of heavy metals from the sample of road run-off from Gladstone Road, Richmond's busiest road, compared to Jimmy-Lee Creek at the upstream end of Beach Road were tenfold higher for aluminium, copper and twofold higher for zinc. Because of the similar ratio of these concentrations to those in the stream, it is likely that the main source of contamination of Jimmy-Lee Creek is from road run-off.

Total suspended solids results were relatively low in Jimmy-Lee Creek and did not appear to correlate with metal or faecal contamination. This suggests that the metals described above are mostly in soluble form.

6.1.2 Semi-Volatile and Volatile Organic Compounds

It was surprising that results for all SVOC's and VOC's were below detection, even the black, turbid sample from the gutter on Gladstone Road.

6.1.3 Nutrients

Nutrient concentrations, while not measured, may be elevated given the percentage cover of macro-algal growth on the stony part of the estuary receiving these rural streams and filamentous green algal growth on the stream bed.

6.2 Faecal Bacteria

Faecal bacteria concentrations in stormwater in Jimmy-Lee, Stillwater and to a lesser-extent Reservoir Creeks were high, even compared to run-off from intensive farmland. The water is unsuitable for drinking by farm animals (ANZECC 2000 Guidelines) at sites on Jimmy-Lee Creek was consistent over both storm events sampled and on Stillwater Creek.

Potential causes for this are dog faeces, leaking sewer pipes or inappropriate sewer connections and ducks. Dog faeces are a well-known issue in urban areas and there is a very popular track alongside Jimmy-Lee Creek upstream of Hill Street where many dogs are let off their lead. Dog poop bags are supplied near the start of this track upstream of Hill Street so dog owners should do the right thing. It is interesting to note that the concentration of *E.coli* upstream of the Reservoir on Reservoir Creek is very low. The track in this area is less well-used as it is a dead-end and becomes steep. It is possible that when dogs use this track they are likely to have defecated downstream further nearer the start of their walk. Regular base-flow monitoring at Easby Park on Reservoir Creek since 2000 shows median concentrations of 85.6 *E.coli*/100ml.

The two ponds where high numbers of ducks exist (Jimmy-Lee Creek at Washbourne Gardens and Stillwater Creek downstream Hill Street) appear to be causing considerable loading of faecal bacteria. The ducks could be reduced in number if they were not fed as much or the amount of open-water habitat was reduced. Residents near the Stillwater Creek pond are now aware of the problem and seem amenable to reduce the amount they feed the ducks. One resident also agrees to stop dumping grass clippings on the stream bank at the waters edge.

7. ECOLOGICAL CONDITION

The macro-invertebrate condition at the Washbourne Gardens and Beach Road sites could be due to high fine sediment inputs from poor sediment retention devices on a subdivision within 1km upstream of this site. Fine sediment deposits on the stream bed upstream of Washbourne Drive averaged between 100-200mm thick. Ducks in Washbourne Gardens are likely to keep a lot of the fine sediment in suspension which results in high turbidity. Macro-invertebrate Community index (MCI) values for the Beach Road site is amongst the lowest recorded for any sample in the Council's database.

Dissolved oxygen, temperature, pH and conductivity were all well within satisfactory levels for aquatic life upstream of Hill Street.

While the fine sediment deposits on the surface of the bed along the Beach Road section were minor (only a thin 1mm layer near the banks), there was a considerable amount in the bed matrix. This, and the contaminant concentrations experienced in this section, are the likely cause of the poor condition of the macro-invertebrate community.

8. MANAGEMENT OF THE SOURCES OF STORMWATER CONTAMINATION

8.1 Residential Catchment

Residential catchments are vulnerable to people tipping waste oil, car wash water and other contaminants down the stormwater drains, as well as the normal burden from vehicle exhausts and tyres. Environmental education attempts to limit this type of activity, and ensure that people understand that "stormwater drains are only for rain".

The other aspect of stormwater management is providing advice on best practice for site management and street design, and motivating people to make the change. In residential catchments the stormwater can be directed to run over swales (grassed areas), which can minimise the run-off of sediments before they enter the streams. It is important that the roadside sumps are correctly maintained to collect the debris and sediments from the roads.

8.2 Rural Catchments

Rural catchments can have fenced riparian strips beside the streams to trap the sediments and prevent stock polluting the waterways.

Piping the stormwater to protect it from run-off from contaminated land is not the best solution, as this deprives the stream life of sunlight, and pipes blocked with storm debris can cause surface flooding.

8.3 Industrial Catchments

Industrial premises that store or use hazardous substances are required to have a stormwater discharge consent if they are discharging more than a thin sheen of fuel (15 mg/l TPH) pursuant to Tasman Resource Management Plan Rule 36. They would require a correctly sized stormwater treatment system that traps the oil and grit. However, it is apparent from these up stream sediment results that, although there has been improvement over the last 5 years, not all of the sites are compliant with respect to the Stormwater Rule, and hazardous substances are leaving the site.

Over the last 10 years Council has required upgrading of many of the Richmond industries and this task is nearly complete. Council's hazardous facility Rule 17.3 requires industries to comply with modern standards.

The timber treatment facility discharging to Vercoes Drain ceased using TBT in 2006 and completed an upgrade of their site and stormwater system in May 2009.

9. CONCLUSION

There are moderate to high levels of zinc and PAH contaminants, exceeding the sediment guidelines, in the sediments of the waterways receiving run-off from commercial and industrial premises in Richmond. The sediments from the residential and rural catchments have low levels of these contaminants.

Two waterways, Vercoes Drain and stretches of Jimmy-Lee Creek along Beach Road, have high levels of heavy metals and PAHs, well above levels lethal to aquatic life. This was confirmed by the absence of any macro-invertebrates sensitive to these contaminants. The Richmond estuary sediments are less contaminated than the contributing industrially impacted streams, and apart from zinc are generally satisfactory.

Water samples showed slightly elevated aluminium, copper and zinc. While these were found to be high in upstream reference sites road run-off is likely to have caused the increase in sites in the lower reaches of Jimmy-Lee Creek. No volatile or semi-volatile organic compounds were found to be an issue. Two non-complying discharges were found during sampling. Faecal bacteria concentrations were particularly high near popular tracks and downstream of ponds that are frequented by high numbers of ducks.

10. FUTURE ACTIONS

10.1 Further Monitoring

- Investigate industries discharging stormwater into Vercoes Drain and Beach Road to determine the source of the high concentration of contaminants.

- Continue site audits and inspections at hazardous facilities against TRMP and HSNO Act rules.

- Institute a regular programme of compliance inspections of Jimmy-Lee Creek along Beach Road, Vercoes Drain, Sicon Drain and Borck Creek to 500m downstream Gladstone Road.

- Continue with the five yearly sediment survey in (2014), just sampling the top 0-30mm.
- Determine the faecal source upstream of Hill Street using microbial source tracking (genetic) techniques.

10.2 Education

Continuation of Council's environmental education programme in relation to urban, rural and industrial stormwater.

10.3 Promote a Review of Policy / Engineering Standards / Consent Requirements

- Zinc discharges from unpainted roofs or roofs with zinc fastenings
- Construction of in-stream ponds to restrict wildfowl faecal loading and increased water temperatures
- Interceptors capable of filtering or removing sediment and oil are installed in key roadside sumps on Richmond's busiest roads

11. RECOMMENDATION

That Council receives this report.

J M Easton
Resource Scientist

Trevor James
Resource Scientist

APPENDIX A: SEDIMENT SAMPLE RESULTS

Units: mg/kg/dry wt	**Sample numbers JME**	**Arsenic**	**Cadmium**	**Chromium**	**Copper**	**Nickel**	**Lead**	**Zinc**	**Dry matter**
Locations		Low 20	Low 1.5	Low 80	Low 65	Low 21	Low 50	Low 200	%
		High 70	High 10	High 370	High 270	High 52	High 220	High 410	
Reservoir Creek Top	517, 518	4.3 4.9	<0.1 <0.1	31 33	28 32	26 33	22 19	190 **200**	74 83
Total	515, 516	4.3 4.6	<0.1 <0.1	34 32	32 32	33 33	27 19	190 170	77 85
Sicon Drain Top	520	18	<0.1	28	13	21	11	82	65
Total	519	15	<0.1	31	26	24	13	79	76
Vercoes Mouth Top	522	9.7	0.13	70	41	**86***	32	**260**	80
Total	521	13	<0.1	70	42	**88***	30	**250**	81
Vercoes Channel Top	526	13	0.48	70	**83**	**90***	23	**270**	71
Total	525	17	<0.1	62	38	**85***	23	**260**	68
Beach Road/ Top	530, 532	7.9 9.5	0.12 <0.1	55 55	33 39	**69*** **65***	30 34	**280** **210**	76 69
Jimmy Lee Ck Total	529, 531	7.5 9.2	<0.1 0.09	56 42	33 30	**76*** **54***	28 37	**270** 160	76 68
North Refuse Top	534, 536	9.2 11	0.3 0.13	73 79	48 45	**79*** **120***	41 43	**200** **200**	37 76
Transfer Station Total	533, 535	7.6 13	0.12 0.12	**80 84**	36 57	**110*** **120***	25 44	150 **260**	62 73
Racecourse Top	538, 540	11 11	<0.1 <0.1	**85 87**	22 20	**110*** **110***	15 14	160 140	78 78
Total	537, 539	9.8 14	<0.1 <0.1	**83** 79	22 24	**110*** **140***	14 15	150 150	76 79
Borck Creek Top	542, 544	5.3 4.6	0.11 <0.1	**180 110**	41 38	**200*** **230***	13 10	120 100	60 63
Total	541, 543	4.9 3.9	<0.1 <0.1	**140 130**	43 37	**210*** **210***	12 9.3	120 100	57 64
Dynea Culvet Top	550, 552	4.3 3.7	**1.7 2.4**	66 67	50 51	**100*** **82***	39 23	**580*** **550***	77 77
Total	549, 551	4.6 3.9	**2.0 1.7**	67 64	49 50	**92*** **85***	11 12	**430** **350**	75 79
Nelson Pine Top	546, 545	7.5 6.5	0.22 0.27	**81 89**	32 26	**140*** **120***	16 16	170 100	36 36
Culvert Total	548, 547	7.1 6.4	0.2 0.2	**91** 77	35 26	**160*** **110***	19 14	130 110	41 35

Note: (1) "Low" and "high" refer to the ANZECC 2000 Interim Sediment Quality Guidelines - those values exceeding low are **bold** and those exceeding high are **bold***.

Table 2: Heavy Metals in estuary sites samples

Units: mg/kg/dry wt	Sample numbers JME	Arsenic	Cadmium	Chromium	Copper	Nickel	Lead	Zinc	Dry matter
Locations		Low 20	Low 1.5	Low 80	Low 65	Low 21	Low 50	Low 200	%
		High 70	High 10	High 370	High 270	High 52	High 220	High 410	
Jimmy Lee at Hill Street	555	12	<0.1	32	30	**25**	15	150	82
Jimmy Lee at Washbourne Gardens	556	12		62	24	**71***	19	**250**	59
Jimmy Lee at 35 Beach Road	558	12	0.12	76	41	**77***	48	**460***	81
Jimmy Lee at McPherson Street	559	10	<0.1	75	36	**99***	**51**	**730***	82
Borck Creek at Railway reserve bridge	557	**27**	0.22	**100**	**75**	**66***	25	**290**	30
Vercoes at boxed culvert	560	**72***	0.21	**120**	**120**	**52***	**58**	**630***	87
Drain opposite Dynea	561	6.1	0.13	**120**	38	**230***	19	120	64
upgradient from NPI									

Note: (1) "Low" and "high" refer to the ANZECC 2000 Interim Sediment Quality Guidelines - those values exceeding low are **bold** and those exceeding high are **bold***.

Table 3: Heavy metals from upstream sites

	Sample numbers JME	PAH low MW	PAH high MW	PAH total
Units mg/kg/dry wt		ISQG Low 0.55	ISQG Low 1.7	ISQG Low 4
		ISQG High 3.16	ISQG High 9.6	ISQG High 45
Location				
Reservoir Creek Top	517, 518	0.05 ND	0.32 0.07	0.57 0.10
Total	515, 516	0.26 0.07	0.79 0.52	1.48 0.87
Sicon Drain Top	520	ND	ND	ND
Total	519	ND	ND	ND
Vercoes Mouth Top	522	0.07	0.25	0.69
Total	521	0.06	0.25	0.70
Vercoes Channel Top	526	0.09	0.56	0.96
Total	525	**6.1***	**18.1***	**32.0**
Beach Road Top	530, 532	0.05 0.47	0.45 **2.68**	0.85 **4.9**
Total	529, 531	**0.62** 0.24	**2.52** 1.29	**4.4** 2.45
North Refuse Top	534, 536	ND ND	0.15 0.19	0.26 0.40
Transfer Station Total	533, 535	ND 0.23	0.23 1.14	0.39 2.64
Racecourse Top	538, 540	ND ND	ND ND	ND ND
Creek Total	537, 539	ND ND	ND ND	ND ND
Borck Creek Top	542, 544	ND ND	ND ND	ND ND
Total	541, 543	ND ND	ND ND	ND ND
Dynea culvert Top	550, 552	ND ND	ND 0.27	0.89 0.51
Total	549, 551	ND ND	ND 0.45	ND 0.93
Nelson Pine Top	546, 545	ND 0.52	0.09 0.80	0.086 1.86
culvert Total	548, 547	ND **6.36***	0.08 6.27	0.075 **17.22**

Note: "Low" and "high" refer to the ANZECC 2000 Interim Sediment Quality Guidelines - those values exceeding low are **bold** and those exceeding high are **bold***.

Table 4: Polyaromatic Hydrocarbons in Estuary Site Samples

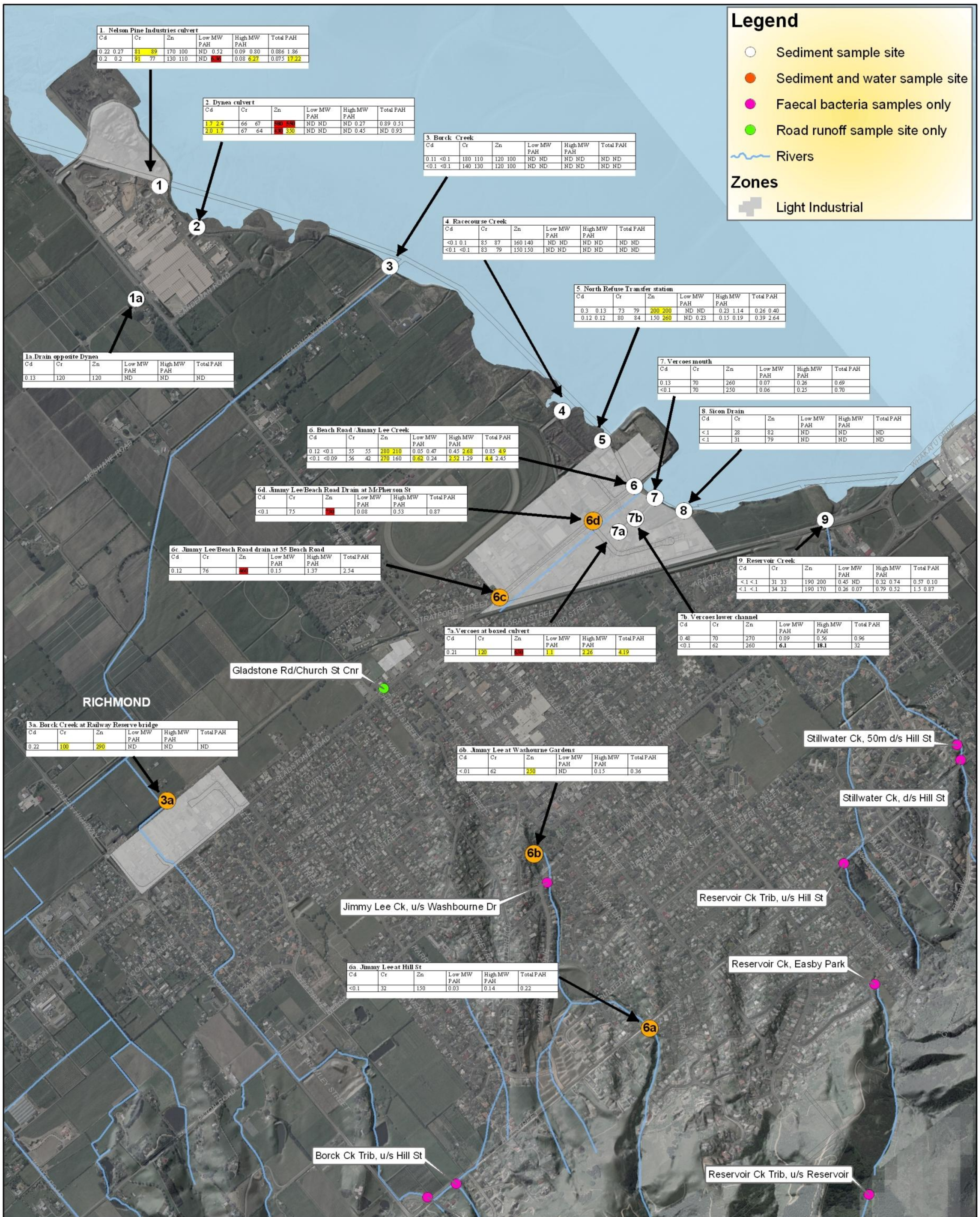
		PAH low MW	PAH high MW	PAH total
Units mg/kg/dry wt	**Sample numbers JME**	ISQG Low 0.55	ISQG Low 1.7	ISQG Low 4
		ISQG High 3.16	ISQG High 9.6	ISQG High 45
Location				
Jimmy Lee at Hill Street	555	0.03	0.14	0.22
Jimmy Lee at Washbourne Gardens	556	ND	0.15	0.36
Jimmy Lee at 35 Beach Road	558	0.15	1.37	2.54
Jimmy Lee Creek at Mc Pherson Street	559	0.08	0.53	0.87
Borck Creek at Railway reserve bridge	557	ND	ND	ND
Vercoes at Boxed culvert	560	**1.1**	**2.26**	**4.19**
Drain opposite Dynea upstream of NPI	561	ND	ND	ND

Note: (1) “Low” and “high” refer to the ANZECC 2000 Interim Sediment Quality Guidelines - those values exceeding low are **bold** and those exceeding high are **bold***.

Table 5: Poly Aromatic Hydrocarbons for Upstream Sites

	Sample numbers JME	PAH low MW	PAH high MW	PAH total
Units mg/kg/dry wt		ISQG Low 0.55	ISQG Low 1.7	ISQG Low 4
		ISQG High 3.16	ISQG High 9.6	ISQG High 45
Location				
Jimmy Lee at Hill Street	555	0.03	0.14	0.22
Jimmy Lee at Washbourne Gardens	556	ND	0.15	0.36
Jimmy Lee at 35 Beach Road	558	0.15	1.37	2.54
Jimmy Lee Creek at Mc Pherson Street	559	0.08	0.53	0.87
Borck Creek at Railway reserve bridge	557	ND	ND	ND
Vercoes at Boxed culvert	560	**1.1**	**2.26**	**4.19**
Drain opposite Dynea upstream of NPI	561	ND	ND	ND

Note: (1) “Low” and “high” refer to the ANZECC 2000 Interim Sediment Quality Guidelines - those values exceeding low are **bold** and those exceeding high are **bold***.



Sediment Quality Guidelines

	Cadmium Cd	Chromium Cr	Zinc Zn	Low MW PAH	High MW PAH	Total PAH
ISQG low	1.5	80	200	0.55	1.7	4
ISQG high	10	370	410	3.16	9.6	45

Note 1: ISQG low and high refer to ANZECC 2000 Interim Sediment Quality Guidelines
Note 2: All concentrations in mg/kg dry weight
key: Contaminant concentrations exceeding ISQG "low" are in yellow. Those exceeding "high" are in **red**.

GIS@TDC

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Concentrations of Selected Contaminants in Sediment & Water near Richmond - 2009-2010

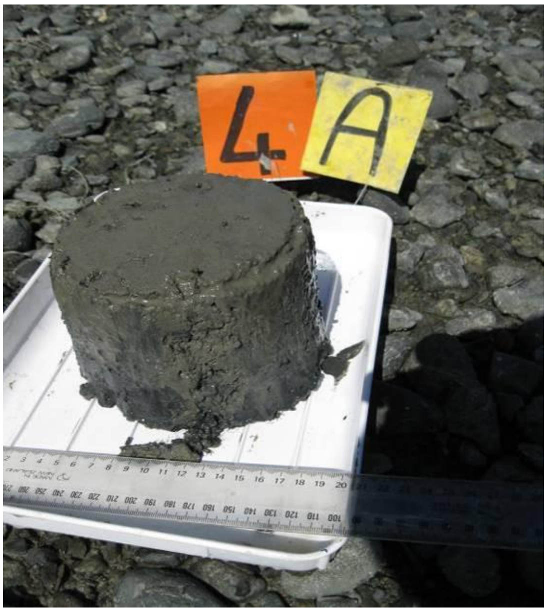
0 250 500 750 1,000 Meters

18 June 2010

tasman district council lifestyle

APPENDIX A:
Selected photos, showing sediment cores and sample sites

Sediment core from urban stream (Reservoir Creek)



Sediment core from Beach Road

Anoxic sediment core from Nth RTS

Anoxic core from Dynea culvert

Upstream sample site Borck Creek, below bridge Railway Reserve

Upstream sample site at 35 Beach Road, part of Jimmy Lee Creek

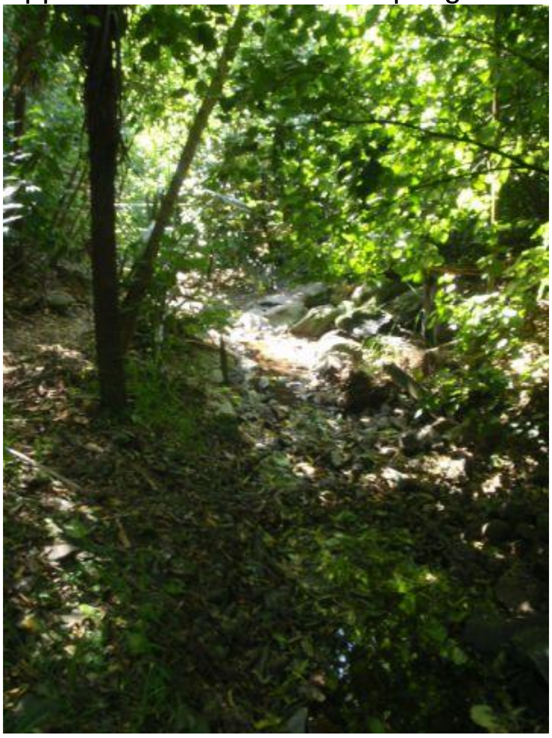
Estuary sample site, mouth of industrial Vercoes Drain

Sample site at estuary edge of Beach Road or Jimmy Lee Creek.

Racecourse stream mouth sample site.

Soft mud at Dynea culvert sample site

Appendix B: Photos of Sampling Sites



Jimmy-Lee Creek at upstream Hill Street

Jimmy-Lee Creek at upstream Washbourne Gardens

Jimmy-Lee Creek at downstream Washbourne Gardens

Jimmy-Lee Creek at 35 Beach Road

Jimmy-Lee Ck at 64 Beach Road

Borck Ck at Railway Reserve (upstream footbridge)

APPENDIX C
Table of GPS Locations and Composition of Sample Cores

Location and GPS	Sites	Samples JME	Grain size and composition of cores	Comments
Reservoir creek	1A	515, 517	SAND to 4cm,SILT & GRAVEL	
2526795 5986105 = 1A	1B	516, 518	As above. Base of sample was orange	1B =2m down stream true left, fine sandy beach
Sicon drain	2A	519, 520	0-3cm SANDY, SILT. CLAY (& fine gravel)	organic, original root mass
2526185 5986110 = 2A				
Vercoes mouth	3A	521, 522	0-3cm FINE GRAVEL SAND, SILT. More silt as go down.	Lower bank, edge estuary. Anoxic silt/clay from 8cm down.
2526077 5986151 =3A				
Vercoes channel	3B	525, 526	GRAVEL,SILT,CLAY,SAND	15m upstream from mouth. Anoxic almost from surface
2526061 5986143				
Beach Road (=Jimmy Lee outlet)	4A	529, 530	0-3cm and 0-10cm GRAVEL,SAND,SILT,CLAY	4A true left. 4B= 1.5m upstream of 4A. Both anoxic 6cm from surface downwards.
2526059 5986250	4B	531, 532	0-3cm and 0-10cm SILT,CLAY,GRAVEL,SAND	
Nth RTS ditch	5A	533, 534	0-3cm SILT,GRAVEL. 0-13cm SILT,ORGANIC STICKS.	5AOutlet end of ponded SW ditch. ~2.5m in from the gravel mound. 5B= 8m from 5A, small, shallow, muddy pool. 5A anoxic right through sediment core. 5B anoxic except top 1-3cm. Very black,& sulphurous odour.
2525860 5986385	5B	535, 536	0-3cm SANDY,SILT,GRAVEL. 0-12cm CLAY,GRAVEL,SAND	
Racecourse stream	6A	537, 538	0-3cm SAND,GRAVEL,SILT 0-13cm SAND,GRAVEL, SILT to 10cm and SILT,SAND,GRAVEL from 10 to13cm.	Mid channel
2525687 5986491	6B	539, 540	Similar profile to above	3m upstream of 6A
Borck stream	7A	541, 542	0-3cm SILT,GRAVEL 0-12cm SILT,GRAVEL, SILT	25m upstream from mouth, muddy tidal area. Black anoxic from2cm.
2524981 5987038	7B	543, 544	Profile similar to above	4m further upstream, and more central
Dynea culvert	9A	549, 550	0-3cm SAND. 0-12cm SAND,SILT,GRAVEL	Both black and anoxic
2524253 5987224	9B	551, 552	Profile similar to above	1m upstream from 9A
NPI culvert	8A	545, 546	0-3cm and 0-13cm SILT & ORGANICS	8A=1m into channel near wing wall, true right. 8B= 6m upgradient in second more northerly pipe, on true left Both anoxic and black beneath 5mm
2524152 5987434	8B	547, 548	Profile similar to above	

TABLE OF GPS LOCATIONS AND COMPOSITION OF UPSTREAM SAMPLES

Location and GPS	Samples JME	Grain size	Comments
Jimmy Lee at Hill Street No GPS - too shady	555	Silty seds.	Upstream from Hill Street, 3m down from the first stream crossing. Noted the SW pipe overflow upright was more than the stream, ~40l/sec
Jimmy Lee at Washbourne Gardens 2525572 5984841	556	Mostly cobbles with fine silt cover.Some mud trapped in vegetation	Longitudinal subsamples, 15m downstream from footbridge to old Jail house.
Jimmy Lee at 35 Beach Road 2525443 5985746	558	Sand and fine gravel, less than 3% silt and clay. Numerous shallow samples.	Green slime on stones, watercress along the edge.
Jimmy Lee at Mc Pherson Street 2525826 5986067	559	More fines than #558	Down from Transport Yard and Tasman Autoparts. Longitudinal collection of small subsamples over 10m.
Vercoes Drain at boxed culvert 2525923 5986017	560	Dominated by gravel and sans, about 1% silt and clay	Now two culverts, one rectangular and one round. Took samples from both.
Opposite the Dynea Drain 2524031 5986947	561	Silt.	This SW ditch comes from the orchard, and is piped under the road. It is actually **not** upstream of the Dynea ditch, as that ditch only drains the seaward side of the main road. This SW drain may go out through the NPI culverts.