This document records technical and factual information used to support the NZTA's Assessment of Environmental Effects for the Pūhoi to Warkworth Project. It has been supplied to the Environmental Protection Authority by the NZTA in response to a section 149(2) Resource Management Act 1991 request. This document did not form part of the NZTA's application for the Project, which was lodged on 30 August 2013.

FURTHER NORTH

Pūhoi to Warkworth
Water Assessment Factual Report 11
Motorway Runoff Report
August 2013

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Puhoi -Warkworth

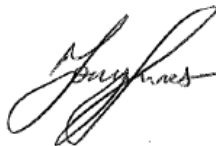|	
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Glossary of abbreviations

Report Relevant Abbreviations	Definition
ANZECC	Australia and New Zealand Environment Conservation Council
ARC	Auckland Regional Council (preceded the Auckland Council)
Cu	Copper
CLM	Contaminant load model
g/m³	Grams per cubic metre
kg	Kilograms
m	Metres
m²	Metres squared
m³	Cubic metre(s)
mg/m³	Milligrams per cubic metre
NZTA	NZ Transport Agency
PAHs	Polycyclic Aromatic Hydrocarbons
t	Metric tonnes
TP10	Auckland Council Technical Publication Number 10: Stormwater Management Devices Design Guideline Manual
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids

Contents

1. Introduction

The purpose of this report is to describe the relative change in water quality in the freshwater and marine receiving environments during the operational phase of the Project as a result of motorway stormwater runoff.

The change in water quality is associated with the change in traffic movement and the increase in road surface associated with the Project, within the Puhoi and Mahurangi catchments. Two methods have been used to reflect the change in water quality. The first method predicts relative changes in contaminant loads on a catchment scale using a Contaminant Load Model. The other method predicts relative changes in contaminant concentrations across several freshwater monitoring sites using existing water quality data.

The results summarised in this report will inform the water quality, freshwater ecology, and marine ecology assessments of effects in relation to this Project and management of the operational phase of the Project.

1.1 Structure of this report

The structure of this report is as follows:

Section 1 - Provides a summary of the purpose and scope this report

Section 2 - Describes the methodology

Section 3 - Describes the Contaminant Load Model results

Section 4 - Describes the results of the contaminant concentration calculations

Section 5 - Provides recommendations and conclusions

2. Methodology

2.1 Existing environment

2.1.1 Freshwater quality

The water quality data collected from six freshwater sites has been summarised to describe the existing water quality. Table 1 provides a description of these sites and Figure 1 illustrates the site locations.

Table 1 Existing freshwater quality monitoring sites

| Monitoring site name	Description
Auckland Council-WTP	Water Treatment site is on the lower Mahurangi river, upstream of SH1 and much of Warkworth
MW	This mid-catchment site will receive runoff from a large area of the project, but with limited urban development in the existing situation
Auckland Council FHQ	This upper-catchment catchment site has no urban development upstream in the existing situation.
P10	This site on the Hikauae Creek has no urban development upstream of the site in the existing situation.
PL	This site on the Hikauae Creek is downstream of SH1.
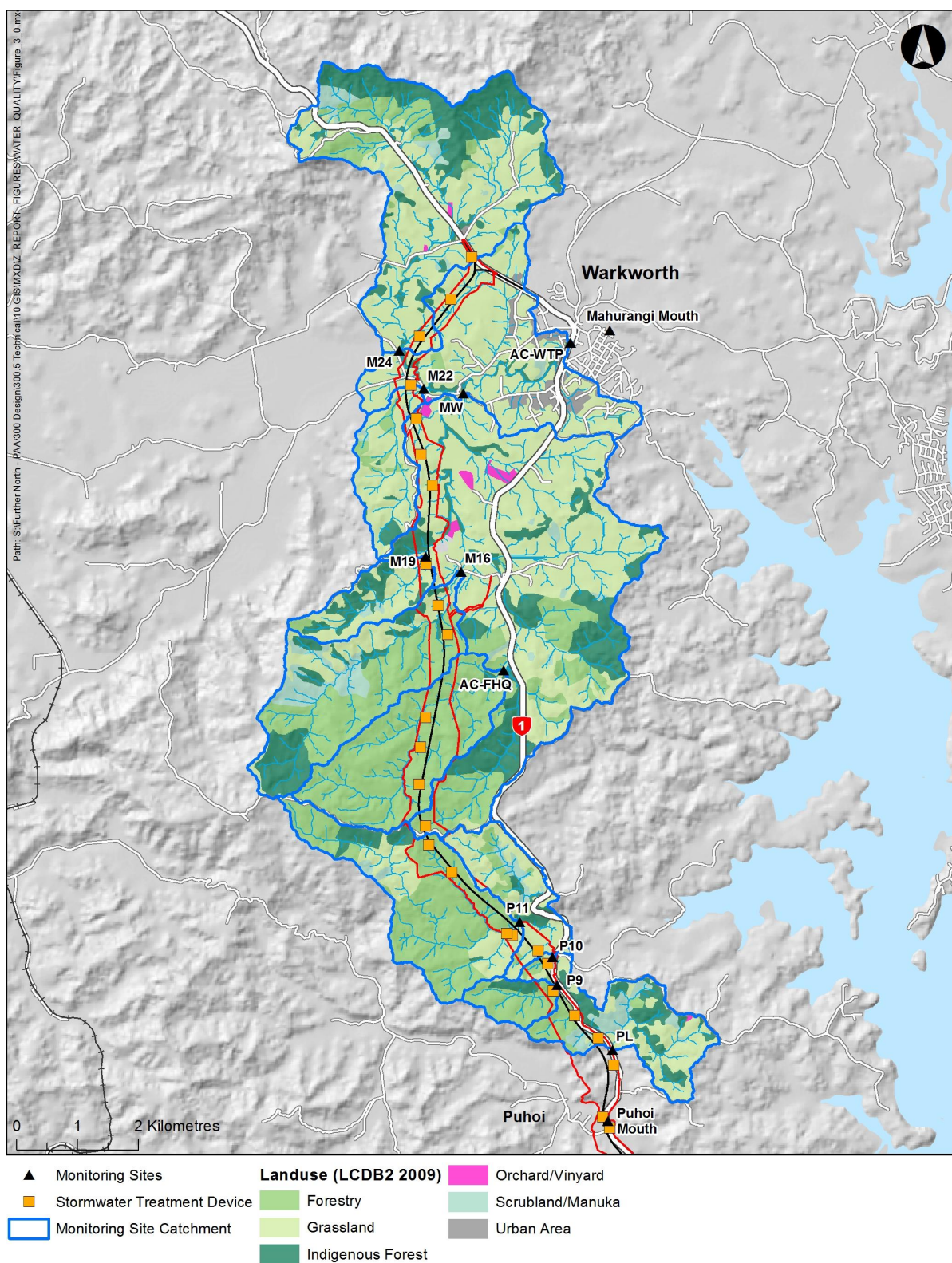
Figure 1: Freshwater Monitoring sites

2.1.2   Sediment quality

Sediment quality is good with all contaminant contributions being below guidelines at all sites sampled in both the Mahurangi and Puhoi Rivers. Estuarine sediment quality assessed in the Marine Ecology Assessment Report identifies that marine sediment quality is also very good in the Puhoi and the lower Mahurangi Estuary. Copper is elevated in the upper Mahurangi Estuary, with Copper detected in the 63μm fraction in the amber ERC range at Vialls Landing and Jamiesons Bay, and above both the ERC red and ISQG-low thresholds in total sediment at Vialls Landing.

The concentration of metals and HMW-PAHs at subtidal sites surveyed was below the ERC amber threshold at all sites, in both total and <63μm fraction. These results are consistent with Halliday & Cummings (2012). The marine sediment sites are discussed in the Marine Ecology Assessment Report.

2.2   Contaminant concentration methodology

The contaminant concentration method provides site specific estimates of the predicted change in contaminant concentrations in freshwater. This methodology provides data for the Freshwater Ecology Assessment Report. It uses observed motorway water quality applied on a weighted catchment basis to estimate contaminant concentrations in receiving environments. It enables the water quality in the existing situation to be compared to water quality guideline values, and for the predicted change in the water quality to be assessed against those guideline values.

There are two sites within the Mahurangi catchment where Auckland Council has collected data since 1993. These sites are Mahurangi at Forestry Headquarters (FHQ) and at the Water Treatment Plant (WTP) at Warkworth.

To obtain existing water quality data for the MW site on the Mahurangi and the P10 and PL sites on the Hikauae Creek, we collected four water quality samples in autumn 2013. The water quality monitoring programme is described in the Factual Report No. 4: Water Quality Monitoring Report, see section 4.1. The existing water quality estimates used for this assessment were calculated from the median of the monitoring results.

The Auckland Council sampling did not include analysis of total petroleum hydrocarbons (TPH). As such, for these two sites, background levels for TPH were based upon the autumn 2013 sampling round.

To determine the impact of the Project upon water quality, the median value for TSS, zinc (Zn), copper (Cu) and TPH from a combined data set was used to estimate the increases in these parameters as a result of the Project. The combined dataset included road runoff data collected as part of NZ Transport Agency (NZTA) research collected from all Auckland motorway sites monitored in the Moores *et al* (2009) study, and a single set of grab-samples collected in Autumn 2013 as part of this assessment from the existing State Highway 1 (Puhoi to Warkworth).

The median values for TSS, total and dissolved Zn and Cu and TPH from the grab-samples collected were compared to the median values from the NZTA research for the Huapai, Northcote, Westgate and Redvale sites (Figure 2 to Figure 7). It was found that the existing State Highway 1 between Puhoi and Warkworth had higher values for TSS, TPH, Total Zinc and Total Copper, but lower values for dissolved Zinc and dissolved Copper. We note that the grab-samples for Puhoi – Warkworth State Highway 1 only consisted of three samples, compared with 300 samples taken over 39 days as part of the Moores *et al* (2009) study. As such, it was considered that the most representative value for contaminant concentration in water from the proposed Project would be

the median value of a combined dataset of both the NZTA research and Puhoi – Warkworth State Highway 1 grab samples.
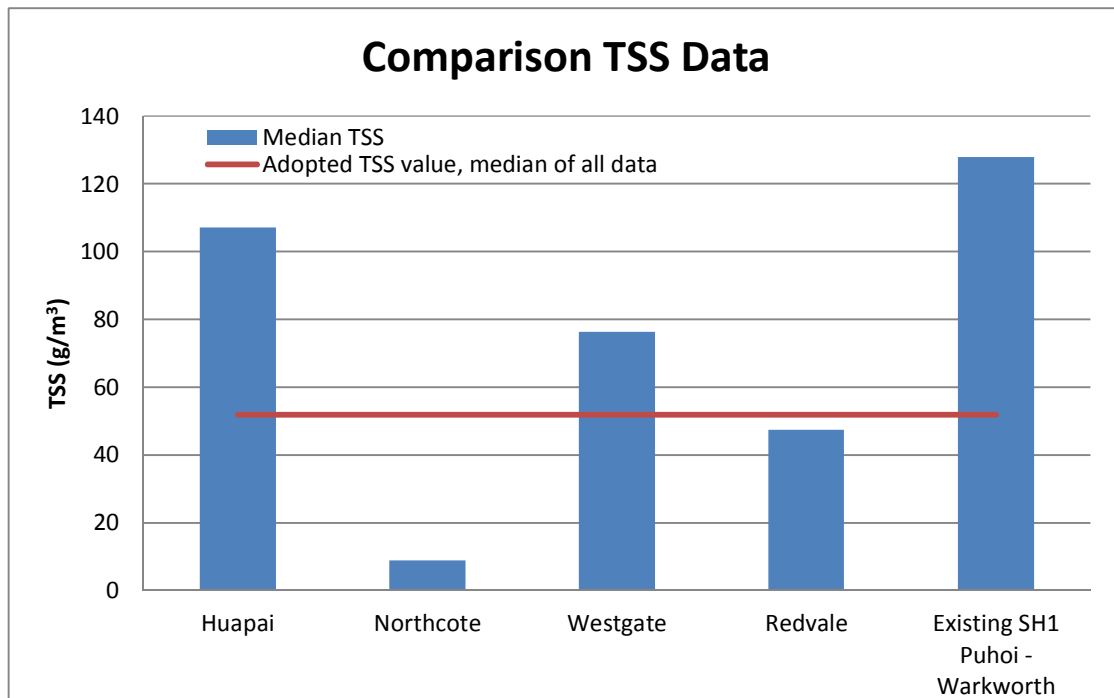
Comparison TSS Data

Figure 2. Total suspended solids results from road runoff for the five water quality sites
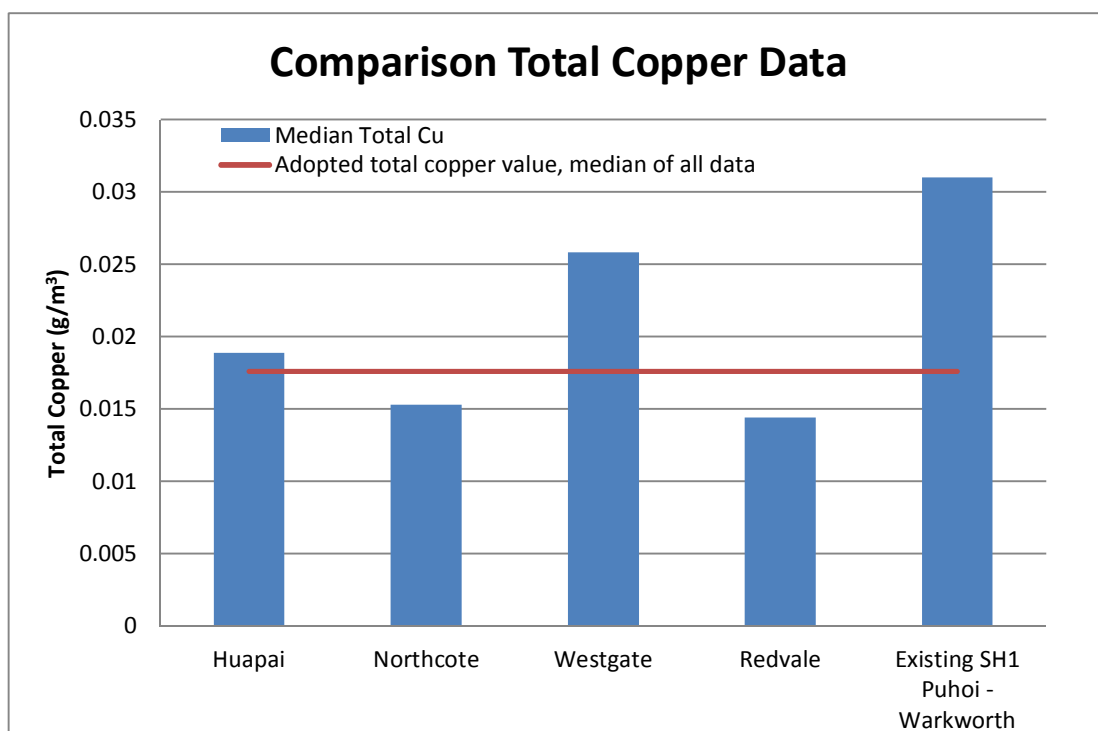
Comparison Total Copper Data

Figure 3. Total Copper results from road runoff for the five water quality sites

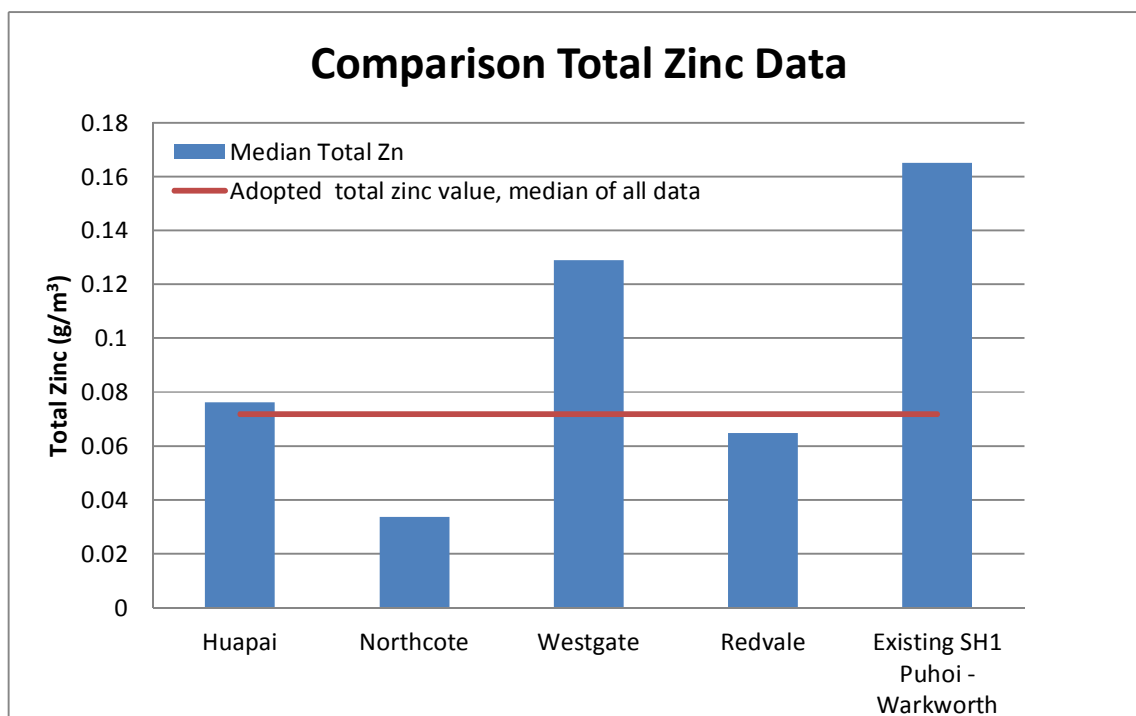**Figure 4. Total Zinc results from road runoff for the five water quality sites**

Figure 5. Dissolved Zinc results from road runoff for the five water quality sites
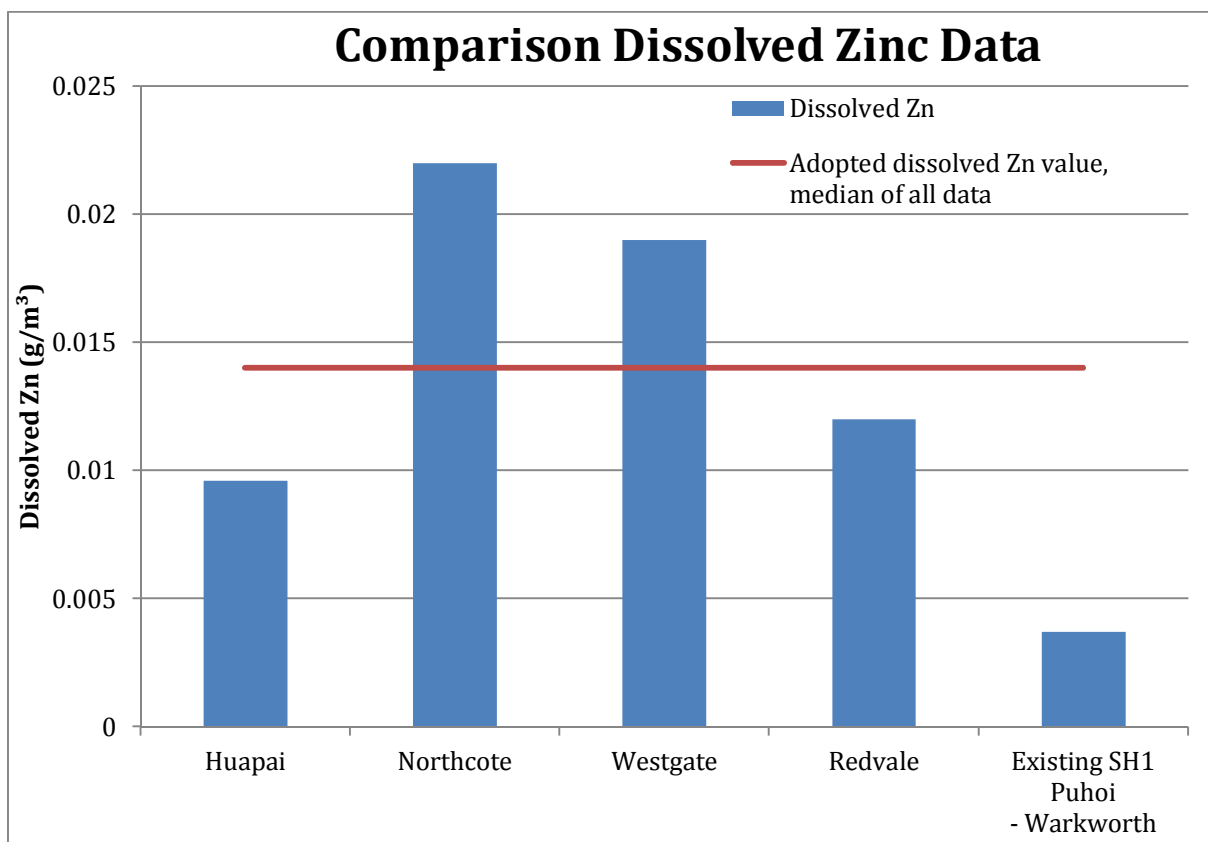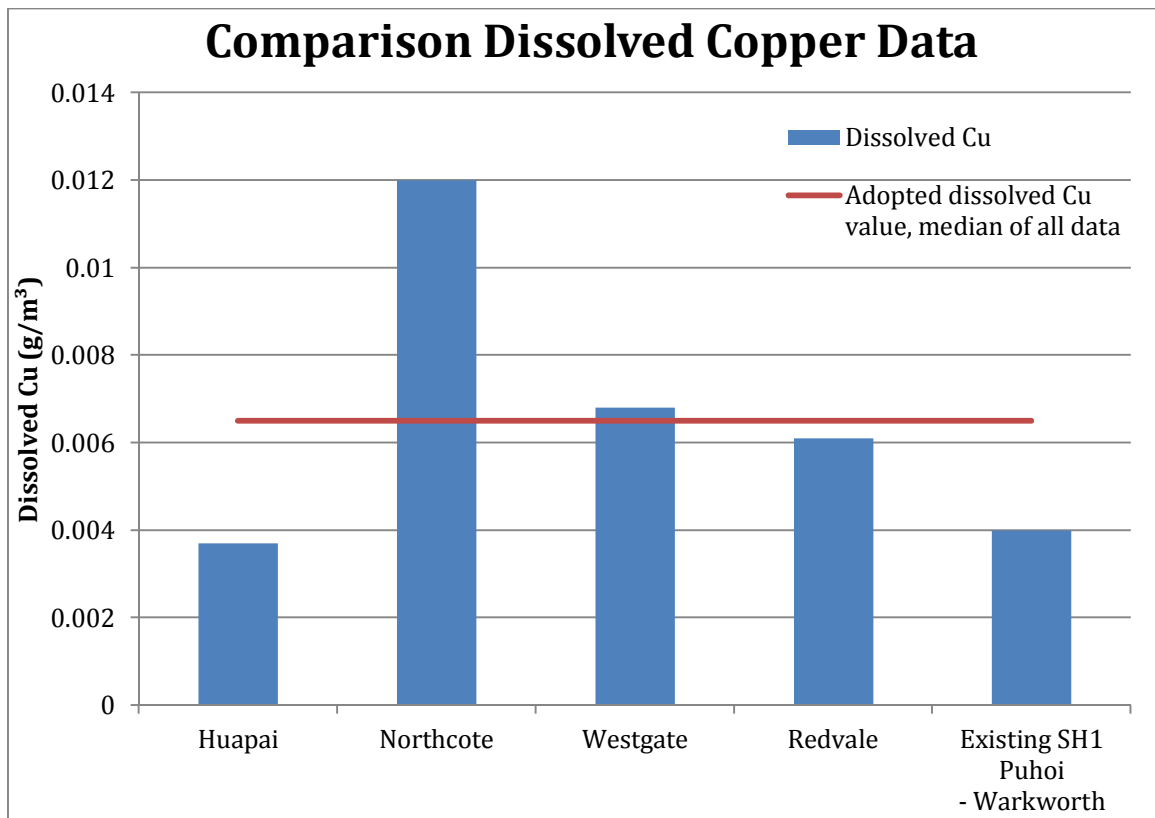
Comparison Dissolved Copper Data

Figure 6. Dissolved Copper results from road runoff for the five water quality sites
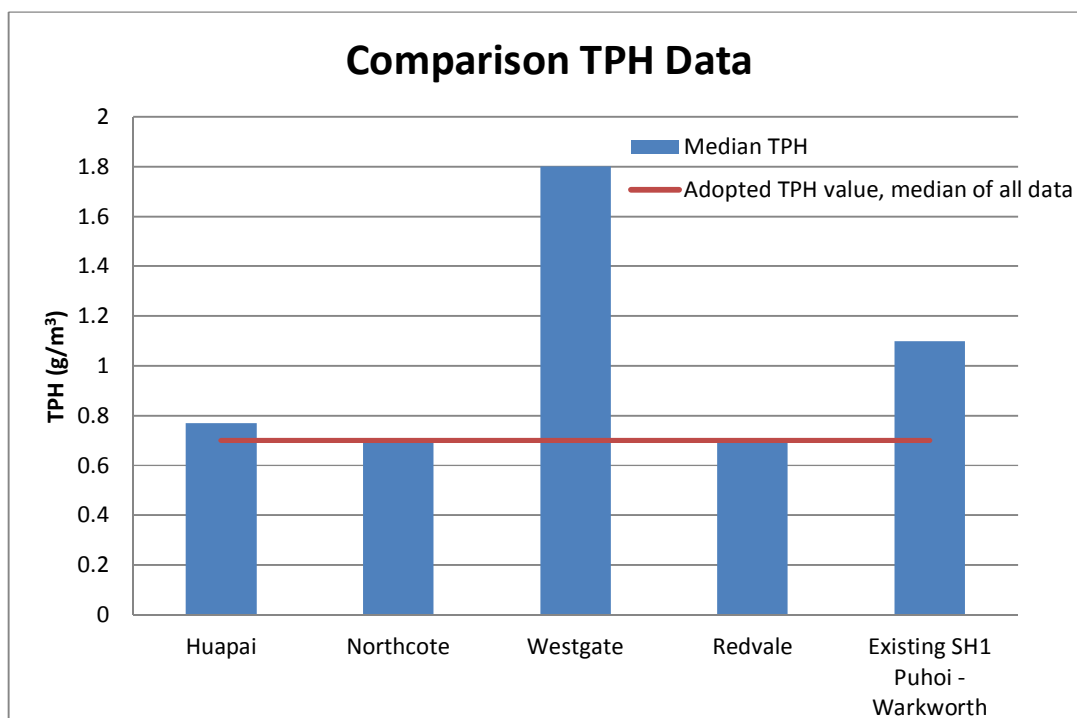
Comparison TPH Data

Figure 7. TPH results from road runoff for the five water quality sites

The contaminant concentration method has limitations:

- It does not account for the change in traffic volumes associated with the change of traffic from existing roads onto the Project, and therefore the change in contaminant distribution expected, including the reduction in contaminant load in some catchments, and
- It does not account for cumulative effects associated with other development that may occur within these catchments in the future case.

We have taken both of these limitations into account in the contaminant load model (CLM) methodology discussed in Section 2, which accounts for the change in traffic and future urban growth.

2.2.1   2031 landuse

The area in each sub-catchment proposed to be converted to the Project was calculated.

It was assumed that this road area would generate contaminants similar to those reported from Auckland Motorway studies (Moores *et al.* 2009). The median value for TSS, Zn, Cu and TPH of the combined data of this study together with grab-sampling undertaken in autumn 2013 was used in the assessment.

A weighted average based on catchment area was used to calculate the predicted change in contaminant concentration as a result of the Project.

Water quality changes in different parts of each stream catchment (upper catchment where existing sub-catchments have very little or no urban development and lower in the catchments) have been estimated to account for the cumulative effects of the road runoff in combination with other currently existing sources of urban runoff.

2.3   Stormwater treatment

2.3.1   Existing treatment

To determine the type of stormwater drainage and treatment in the existing catchments a walk-over site survey was undertaken focusing on SH1 and the main roads. The load reduction factor for open roadside drains, which serve a significant proportion of SH1 and the rural roads within the Puhoi and Mahurangi catchments, were taken from Moore *et al.*'s (2010) study of road runoff at four motorway locations in Auckland. This study included an analysis of TSS, total zinc and total copper loads by the roadside drainage channel at Huapai. This study found that while these drainage systems are not specifically designed or constructed as systems for the removal of contaminants; TSS, copper and zinc discharged via road runoff are retained by these systems to some extent. Table 2 shows the predicted contaminant load removal rates under the drainage regime.

The load reduction factors applied to the existing road are used to establish the baseline contaminant load. We consider it a conservative assumption to account for the potential treatment from the open road drains that serves SH1 and other rural roads within the catchments. The treatment values used for infiltration ditches are high compared with the values assumed for wetlands. However, as infiltration ditches provide the existing treatment, we consider this to be a conservative assumption. If we assumed lesser potential treatment from the existing drainage, we could overestimate the water quality benefits that could be expected from the predicted movement of traffic off SH1 and onto the proposed Project road.

Table 2. Percentage contaminant load removal under the existing road drainage systems.

Treatment Device	Total suspended solids %	Zinc suspended particulate and dissolved %	Copper suspended particulate and dissolved %	TPH %
Catchpits	20	11	15	20
Open road side drains	60	80	80	N/A (see note)

Notes: TPH was collected from untreated road runoff at Huapai, (Moores, *et al* 2009) but all samples were below the detection limit, and therefore the performance of the open roadside drain could not be determined.

2.3.2 Proposed treatment

The Operational Water Assessment Report proposes that wetlands designed to meet the Auckland Council's TP10 standard will be adopted to treat all the motorway runoff.

The CLM's default load reduction factors were used to estimate the reduction in contaminants from wetland treatment. The CLM provides estimates in the reduction of the combined particulate and dissolved fractions of metals.

Auckland Councils TP10 guidance (ARC, 2003) also provides a range for estimated removal of dissolved metals by constructed wetlands. These ranges are 46% -87% for dissolved zinc and 43% - 62% for dissolved copper. For this analysis it was assumed the constructed wetlands would remove 50% of dissolved zinc and 40% of dissolved copper. Table 3 shows the effect of the proposed treatment on contaminant loads.

Dissolved metals are the more bioavailable than the metals in particulate form, and therefore the predicted change in the dissolved concentration is the most relevant for ecological assessments.

Table 3. Percentage Rates of contaminant load removal under the proposed treatment systems.

Treatment Device	Total suspended solids %	Total Zinc %	Dissolved Zinc %	Total Copper %	Dissolved Copper %	TPH %
Constructed wetland	80	60	50	70	40	60

2.4 Contaminant load model methodology

The contaminant load model (CLM) Version 2, is a spreadsheet-based model which has been developed to enable estimations of stormwater contaminant loads on an annual basis. The model is very simple in principle – the area of a particular land use (source) within the study area (the

catchment) is multiplied by the quantity of contaminants discharged from that land use (source yield) to provide an annual load from that source. The loads from each source within the catchment are then added together to provide an annual contaminant load for the catchment of interest.

The CLM was developed and calibrated to estimate the annual loads, i.e. kilograms per year (kg yr-1), for the following contaminants in stormwater from large, heterogeneous urban areas of the Auckland region. The CLM estimates contaminant loads for four water quality parameters:

- Total suspended solids (TSS);
- Total zinc;
- Total copper; and
- Total petroleum hydrocarbons (TPH).

The CLM is used for sites that are predominantly urban (i.e. greater than approximately 80%). Both the Puhoi and Mahurangi catchments have rural land well in excess of 20%. For this study, as recommended in the CLM user's manual (ARC 2010a), we have only modelled the urban part of these catchments with the CLM.

The CLM has several limitations:

- The loads estimated should be treated as relative loads between the various scenarios (i.e. with and without project and with and without treatment); and

- The CLM produces estimates of average annual loads rather than concentrations. It can be used to inform our understanding of the relative changes in the accumulation of contaminants within the Mahurangi and Puhoi estuaries, but cannot be used to compare directly against ecological trigger values, which are related to contaminant concentrations in water and sediment.

CLMs have been developed for two catchments, illustrated in Figure 1:

- Puhoi River, and
- Mahurangi River.

The CLMs were built to represent traffic and landuse at 2031 and describe the "with project" and "without project" scenarios to include stormwater treatment. The CLM provides data for the Marine Ecology Assessment Report.

2.4.1 Existing landuse

The first division of a catchment is into urban and rural areas.

The CLM considers urban areas to comprise only the six sources listed below, although roofs, roads, paved surfaces and urban grasslands and trees are further subdivided as noted.

- roofs divided into nine different types of material;
- roads divided into six different vehicles/day categories;
- paved surfaces, other than roads and roadside footpaths, divided into residential, commercial and industrial;
- urban grasslands and trees divided into three different slope categories;
- urban streams; and
- construction sites, which are considered to be 100% bare earth for the purposes of estimating contaminant loads.

To calculate the land use areas within each category, aerial photography, land cover database 2, district plan maps, building footprint spatial layer and impervious surface spatial layer were referenced.

A walk-over survey of Warkworth was undertaken and the roofing types of 364 buildings were identified. This information was used in conjunction with aerial photographs to describe the roofing material within the urban areas.

2.4.2   2031 landuse

The increase in population at 2031 was based on the population assumptions used in the traffic modelling and detailed in the Transportation and Traffic Modelling Assessment Report. The "with project" scenario includes an estimated additional increase in population of 1% per annum growth, in addition to the predicted population growth.

To accommodate the assumed 2031 population we have increased the urban area within Warkworth. To calculate the increased urban area associated with the predicted increase in population, we made the following assumptions:

- Land parcels 1000m^2;
- Roof area 150m^2;
- Impervious area of each parcel: 500m^2;
- One dwelling per parcel; and
- Three people per dwelling.

These assumptions are consistent with the recommendations in the CLM User Manual (ARC2010a) and are broadly representative of recent urban growth in Warkworth based on the analysis of aerial photography.

The population assumptions used for the CLM are consistent within the assumptions used for the traffic modelling. The traffic modelling methodology is described in the Transportation and Traffic Modelling? Assessment Report.

2.4.3   Traffic assumptions

The CLM uses vehicle per day traffic loads to calculate contaminant loads from road runoff.

The traffic assumptions used for the CLM come from the results of the traffic modelling described in Transportation and Traffic Modelling Assessment Report. We used a linear interpolation between the 2026 and 2051 vehicles per day estimates to calculate the vehicles per day (VPD) at 2031.

The CLM classifies contaminant loads for categories of vehicles per day. The roads in each VPD class have default areas. Table 4 provides a summary of the CLM default road areas in square metres, for roads with varying VPD counts.

Table 4. Road area and vehicles per day.

Vehicles per day	Area per 1m length of road. (m²)
<1000	17
1000-5000	17
5000-20000	17
20000-50000	21
50000-100000	24
>100000	31

In the 2031 "without project" scenario the existing SH1 has an estimated traffic load of between 20,000-50,000 VPD, but is only on average approximately 15m wide. The defaults therefore overestimate the width of the SH1 road and may overestimate the contaminant loads, and in particular the TSS load associated with the existing SH1. However, it is vehicles rather than the paved road surfaces that contribute most of the contaminant loads (Moores *et al* 2009). We consider the default values within the model appropriate to represent the contaminant loads from SH1.

For the 2031 "with project" scenario, the P-WK road has an estimated traffic volume of 16,000 – 23,000 VPD. The design proposes the road will be on average approximately 29m wide. The defaults areas within the CLM would underestimate the road area. To be conservative we have used the proposed road width of 29m to calculate the contaminant loads.

3.   Contaminant concentration results

3.1   Contaminant concentration results

Existing water quality assessments presented in this section are based on long term water quality data from Auckland Council (sites Mahurangi at FHQ and Mahurangi at WTP) and grab sample data (sites MW, P10, PL, Mahurangi Mouth and Puhoi Mouth) collected as part of this study. The Water Quality Monitoring Report describes these data-sets. The existing water quality estimates used for this assessment were calculated from the median of the monitoring results.

Water quality may vary significantly in response to rainfall events and over seasons, and therefore the results based on the grab samples are not as robust as the results based on the long-term data for the two Auckland Council sites. We intend that the short- term monitoring data summarised in this report is used as an approximate guide to describing the existing water quality and to indicate where an obvious water quality problem may exist that warrants further investigation.

We have compared the existing baseline water quality and predicted post-development with treatment metal concentrations to the Australia and New Zealand Environment Conservation Council (ANZECC) (2000) guideline trigger values for the 95% level of species protection in freshwater for slightly-to-moderately disturbed ecosystems. We have adjusted trigger values to account for water hardness (moderate hardness category). The ANZEC trigger levels in freshwater are 0.0163 mg/L for zinc and 0.0028 mg/L for copper. In marine water the trigger levels are 0.0150 mg/L for zinc and 0.013 mg/L for copper. The ANZECC trigger values are generally accepted as low-risk ecological trigger levels.

Dissolved metal species are the most bio-available fraction and we consider these the most important in assessing the effects of metal toxicity on aquatic organisms. This report presents both the dissolved and total metal results compared against the ANZECC (2000) trigger values described above. The interpretation of the stormwater concentrations against the guideline values may not necessarily be representative of the acute effects of short-duration pulses of contaminants that occur during rain events. We intend that the data illustrated in the graphs below, be used to inform the Freshwater Ecology Assessment Report. The freshwater ecologists will consider the predicted changes in water quality and its ecological effects in the ecological assessment of the freshwater environments.

The water quality results shown in Figure 8 to Figure 17 illustrate the existing concentrations and predicted increase in TSS and total and dissolved zinc and copper for the five freshwater locations and the two river mouths under two scenarios: the baseline, "without project"; and "with project, with treatment".

The water quality results shown illustrate the existing concentrations and predicted increase in TSS and total and dissolved zinc and copper for the two river mouths under two scenarios: the baseline, "without project"; and "with project, with treatment".

The laboratory operating limits (LOR) (minimum value that can be analysed) varies in the sampling undertaken for this project when compared to Auckland Council data and also in the analysis undertaken in freshwater and saline environments. Reported laboratory operating limits are however always lower than the guidelines against which results are being compared. Therefore variations in detection limits do not affect analysis of the data.
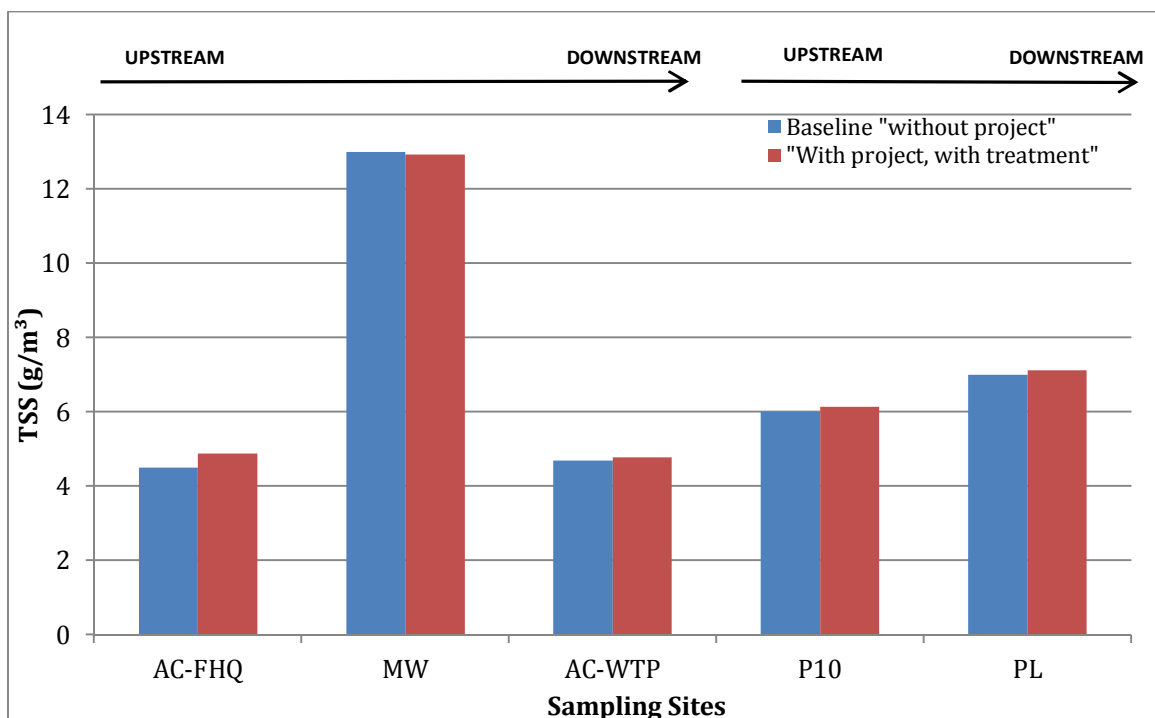
Figure 8. Total suspended solids results from the five water quality sites at 2013.
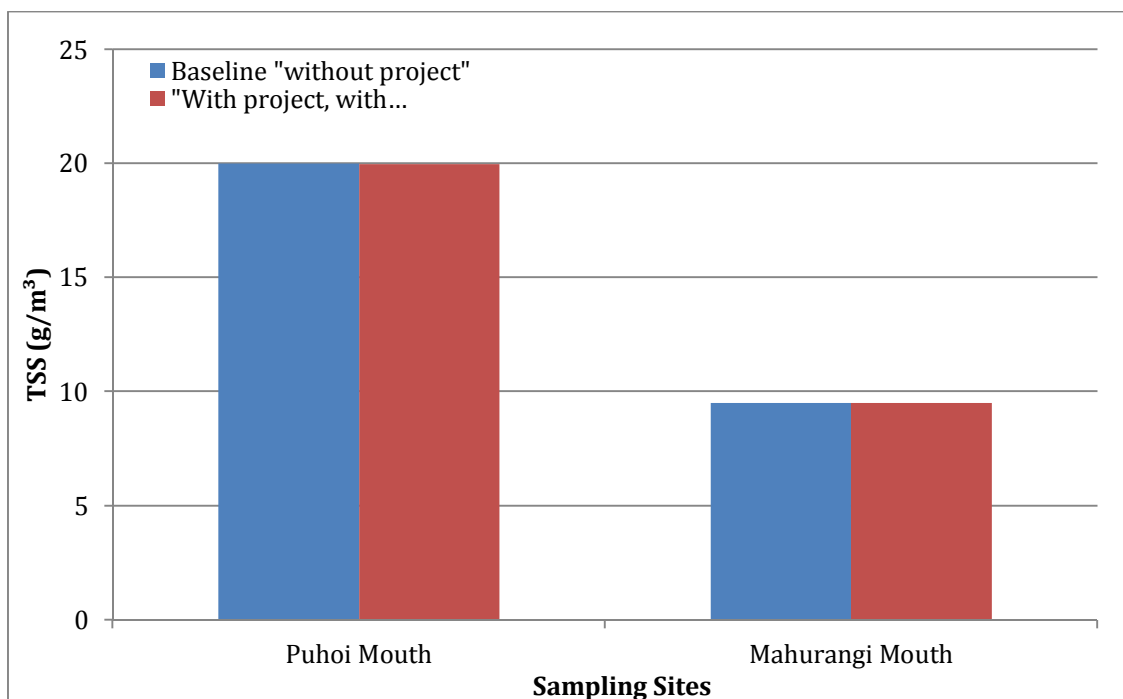

Figure 9. Total suspended solids results from the River Mouths water quality sites at 2013.

3.1.1 Total Suspended Solids

Total suspended solids concentrations for the "with project, with treatment" scenario show similar values to the baseline "without project" values.
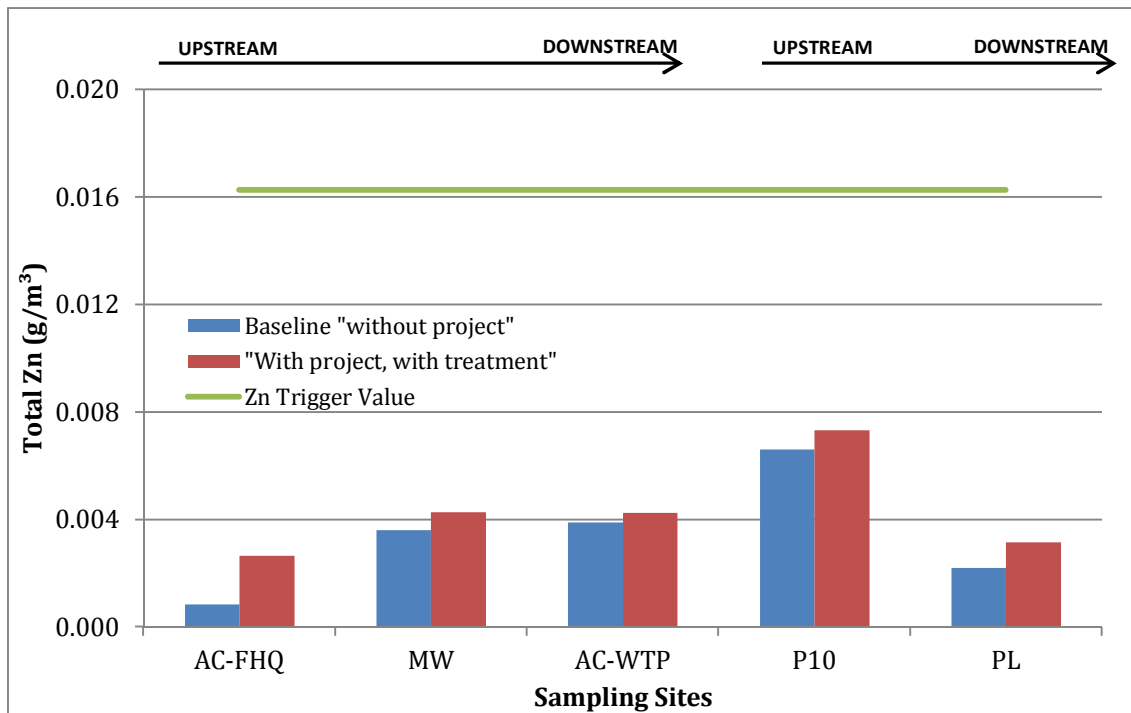

Figure 10. Total zinc concentrations at the five water quality sites at 2013.
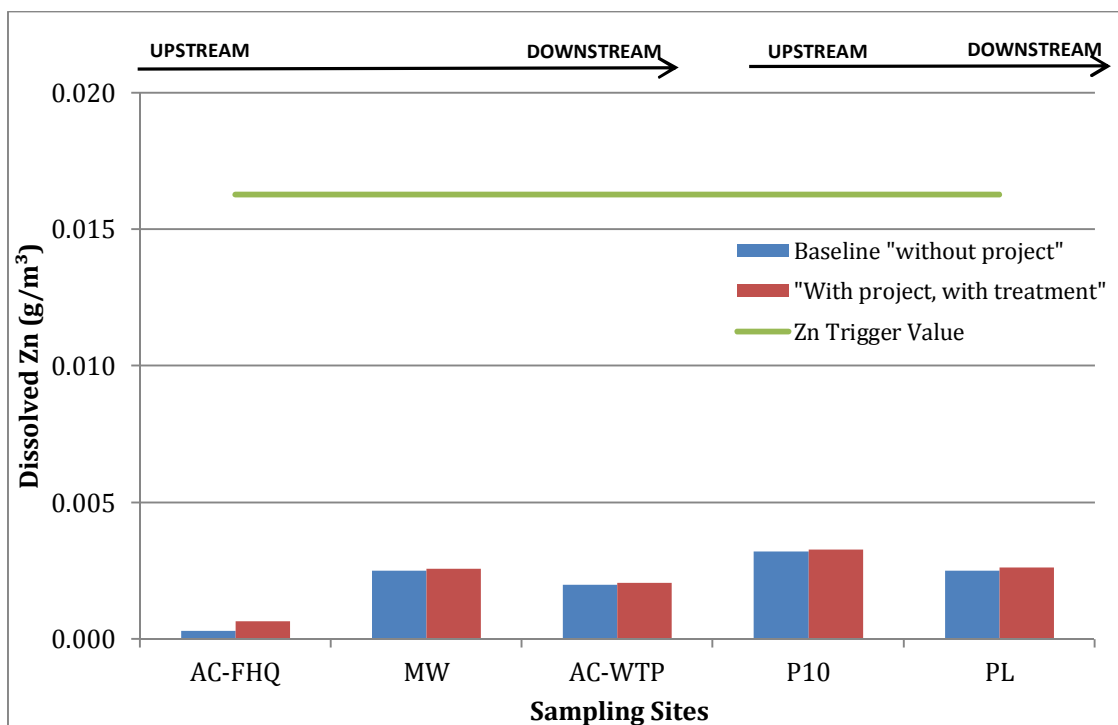
Figure 11. Dissolved zinc concentrations at the five water quality sites at 2013.
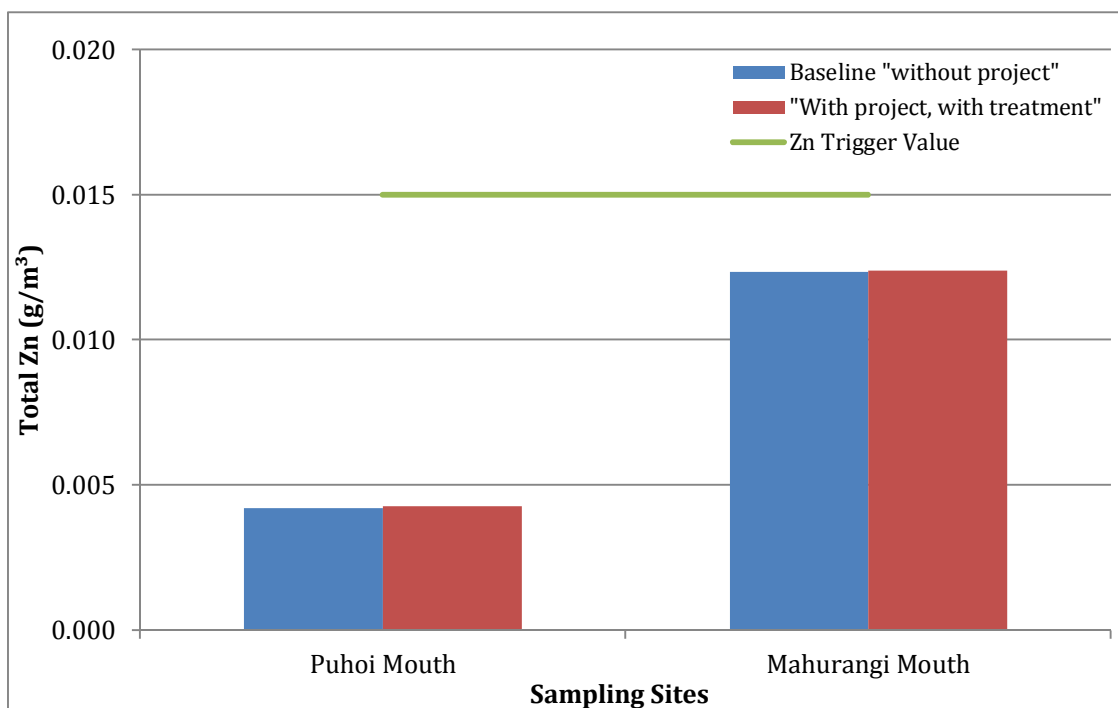

Figure 12. Total zinc concentrations at the River Mouths water quality sites at 2013.
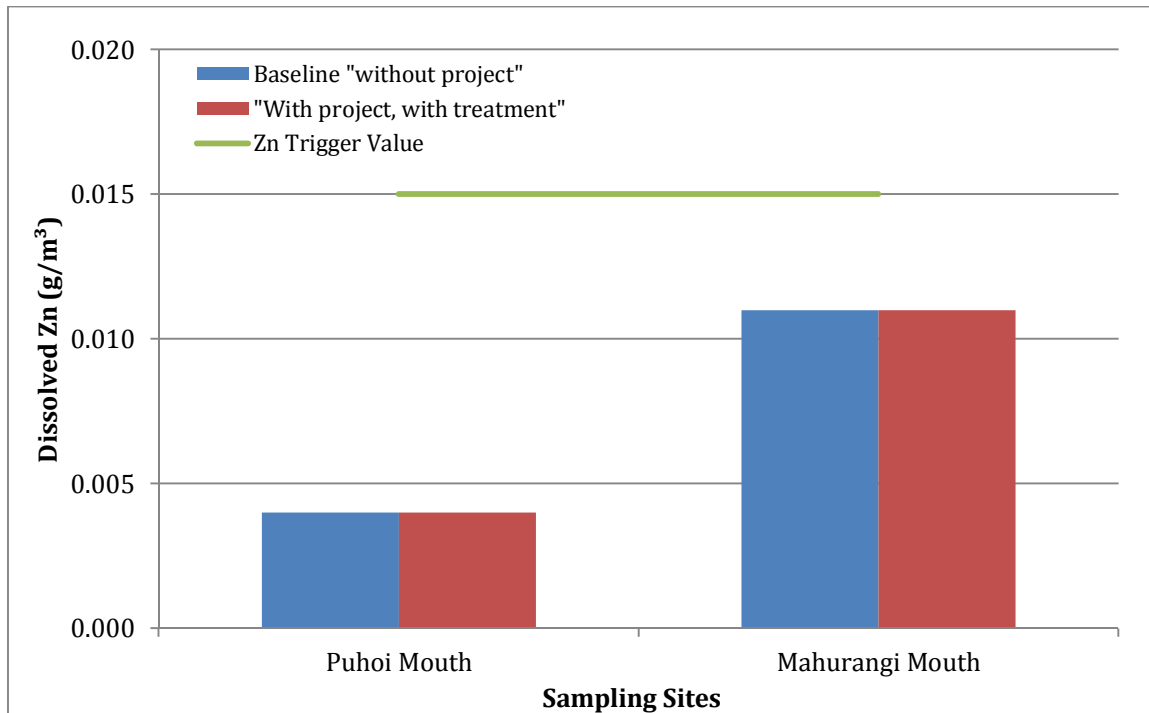
Figure 13. Dissolved zinc concentrations at the River Mouths water quality sites at 2013.

Figure 14. Total copper concentrations at the five water quality sites at 2013.

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Figure 15. Dissolved copper concentrations at the five water quality sites at 2013.

Figure 16. Total copper concentrations at the River Mouths water quality sites at 2013.

Figure 17. Dissolved copper concentrations at the River Mouths quality sites at 2013.
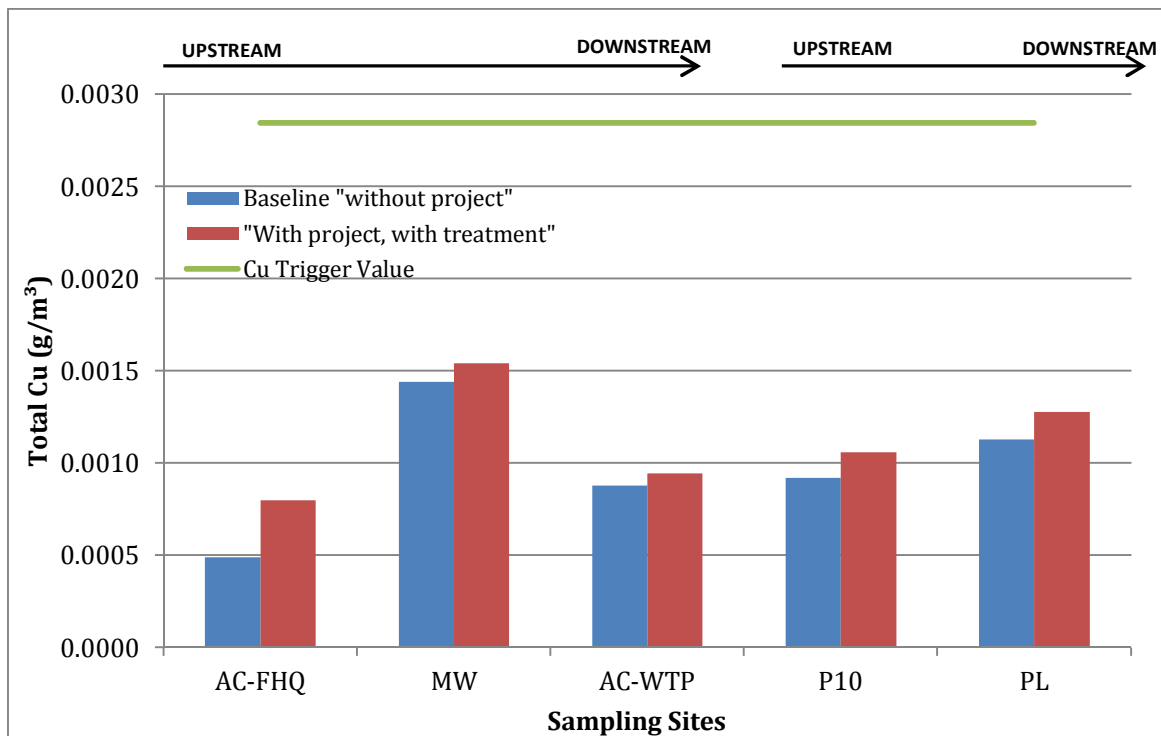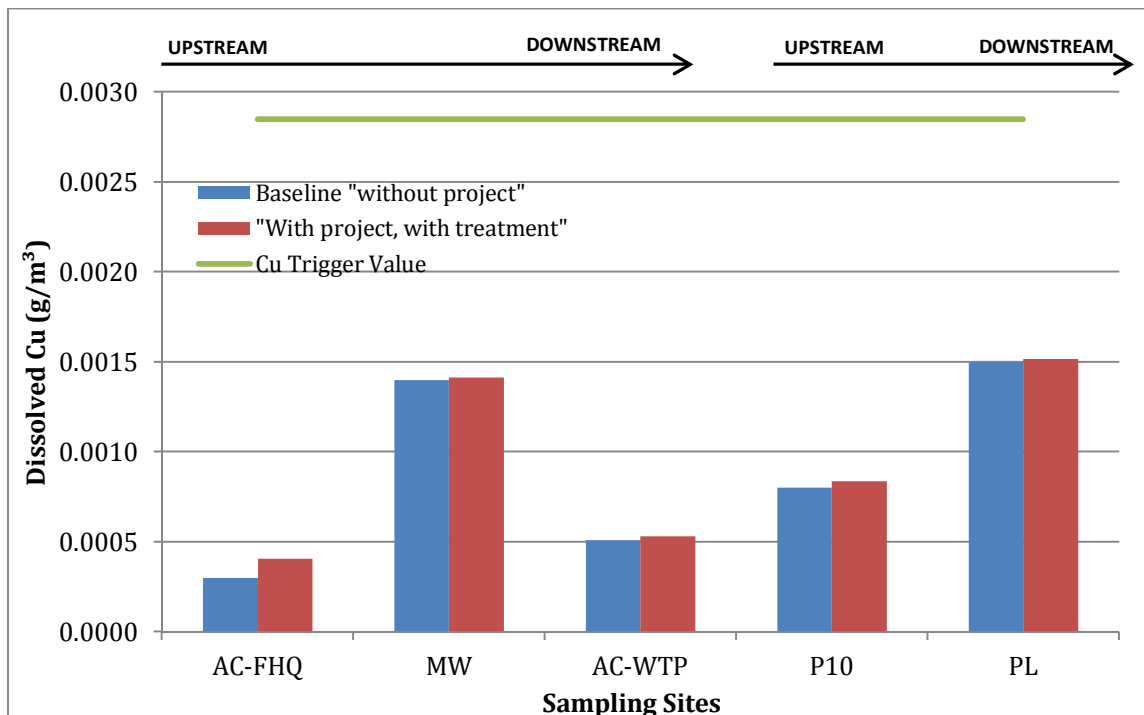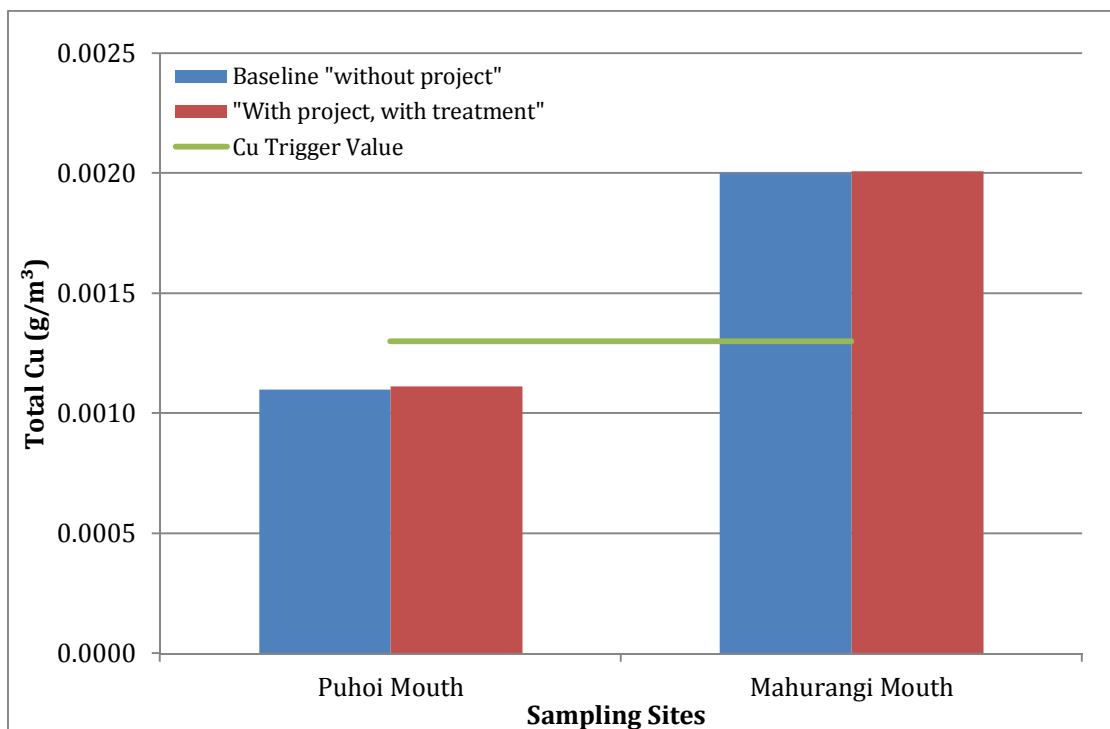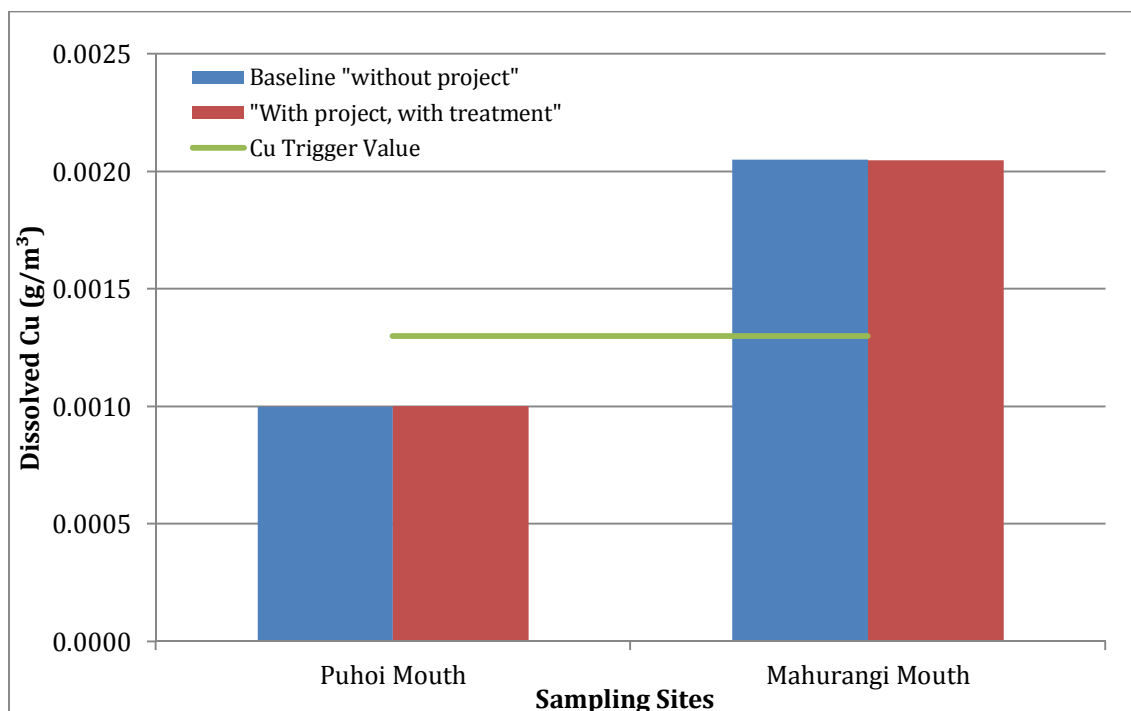
3.1.2   Metals

In the existing situation, the water quality at all the freshwater sites is considered to be good, with metal concentrations well below the ecological trigger values. Concentrations are slightly more elevated compared to marine guidelines at the mouths with copper being above guidelines at the Mahurangi, however no change is expected with the Project in place.

With the increase in contaminants associated with motorway runoff added, contaminant concentrations will increase at all sites. The largest proportional increases occur in the catchments where the road footprint makes up a larger proportion of the overall catchment.

With the wetland treatment accounted for, the predicted total and dissolved zinc and copper concentrations at the five sites are all below the ANZECC (2000) guideline trigger values for 95% level of species protection in freshwaters. All sites show values similar to those of baseline water quality within the "With project, with treatment" case.

Therefore we expect that only a very minor change in freshwater quality and freshwater sediment quality as a result of the Project.

3.1.3   Total Petroleum Hydrocarbons

Baseline TPH concentrations were only available from the short-term grab-sample monitoring as Auckland Council did not have aqueous TPH data. All baseline TPH concentrations for all petroleum hydrocarbon fractions and total hydrocarbons were below the laboratory limits of reporting of 0.7g/m³. Conservatively, baseline values for TPH were thus taken as equal to 0.7g/m³. The median value for TPH from the combined NZTA research road runoff data/State Highway grab-sample data was 0.7g/m³. As such, for the "With project, with treatment" case, TPH values were slightly below

or equal to 0.7g/m^3 all sites indicating that no change is expected to TPW concentrations with the new road in place following treatment of the stormwater in wetlands. There are no ANZECC (2000) guideline trigger values for TPH in aqueous solutions.

4. Contaminant load model results

4.1 Contaminant load model results

The results summarised in Table 5, Table 6 and Table 7 illustrate the predicted relative change in contaminant loads in the baseline "without project" and "with project, with treatment" scenarios.

Table 5 CLM predicted relative change in contaminant loads in the Puhoi River catchment at 2031

Treatment Device	Average Annual Total Load (kg/yr)			
	TSS	Zn	Cu	TPH
Baseline "without project"	105178.00	34.80	8.81	321.50
"With project" With treatment"	104733.00	39.00	8.96	328.50
Percentage change	-0.4%	12.1%	1.7%	2.2%

Table 5 above shows the contaminant loads in the Puhoi River catchment for the baseline "without project" scenario and the expected contaminant loads for the "with project and with treatment" scenario. Treatment is through the proposed constructed wetland system.

The Puhoi catchment has very little urban development at present, with the exception of SH1. Therefore the background levels for Zn, Cu and TPH are relatively low. The increases in all contaminants except Zn are very low. The 12% increase in zinc is related to the Puhoi section of the Project road having the greatest predicted vehicles per day, and because the section of the existing SH1 within the Puhoi is served by infiltration ditches currently in places. For this analysis we have assumed the existing infiltration ditches have high rate of metals removal based on the Moores et al (2010) study. This assumption is considered conservative, and may underestimate the relative benefits of wetlands.

Table 6 CLM predicted relative change in contaminant loads in the Mahurangi River catchment at 2031

Treatment Device	Average Annual Total Load (kg/yr)			
	TSS	Zn	Cu	TPH
Baseline "without project"	149280	453.4	48.36	571.1
"With project" With treatment"	148149	459.2	48.80	564.1
Percentage change	-0.8%	1.3%	0.8%	-1.2%

Table 6 above shows the contaminant loads in the Mahurangi River catchment for the baseline "without project" scenario and the expected contaminant loads for the "with project and with treatment" scenario. Treatment is through the proposed constructed wetland system. The results suggest the impact associated with the project will be negligible.

The Mahurangi River catchment includes the Project and includes the Warkworth urban area. Table 7 excludes the urban growth that has been assumed in Table 6, to accommodate the 1% annual population growth that was used in the traffic modelling. Again, the results suggest the impact associated with the project will be negligible.

Table 7 CLM predicted relative change in contaminant loads in the Mahurangi River catchment at 2031 (excluding the 1% additional urban growth assumed in the "with project" scenario)

Treatment Device	Average Annual Total Load (kg/yr)			
	TSS	Zn	Cu	TPH
Baseline "without project"	149280.00	453.40	48.36	571.10
"With project" With treatment and without additional growth"	148136.0	458.40	48.8	564.1
Percentage change	-0.8%	1.1%	0.8%	-1.2%

4.1.1   Predicted change in marine sediment quality

Sediment quality is good with all contaminant contributions being below guidelines at all sites sampled in both the Mahurangi and Puhoi Rivers. Estuarine sediment quality assessed in the Marine Ecology Assessment Report identifies that marine sediment quality is also very good in the Puhoi and the lower Mahurangi Estuary. Copper is elevated in the upper Mahurangi Estuary, with Copper detected in the 63µm fraction in the amber ERC range at Vialls Landing and Jamiesons Bay, and above both the ERC red and ISQG-low thresholds in total sediment at Vialls Landing.

The concentration of metals and HMW-PAHs at subtidal sites surveyed was below the ERC amber threshold at all sites, in both total and <63µm fraction. These results are consistent with Halliday & Cummings (2012).

Oldman *et al*. (2009) suggest that 80% of the sediment entering the Mahurangi harbour is deposited in the estuary with the majority of sediment deposited in the upper estuary. The Harbour modelling undertaken for this project and described in the harbour modelling report supports Oldman et al (2009) conclusions. Similarly for the Puhoi catchment the modelling undertaken for this Project has been used to estimate that 70% of sediment is likely to be retained within the Puhoi estuary (Coastal Processes Report).

The CLM describes the increase in total contaminant loads. The contaminants in the dissolved phase are likely to be diluted within the marine environment and flushed from the estuary within 2 days (Coastal Processes Report). The motorway runoff data reported in Moore (2010) indicates that on average 45% of the total copper and 31% of the total zinc in runoff was in the dissolved phase.

While a 12% increase in Total Zn is predicted in the Puhoi catchment, the actual load predicted is 4.2 Kg/per year. This is less than predicted in the Mahurangi, and the total load predicted in the "with project, with treatment" scenario for the Puhoi of 39kg/ha compares with the existing load in the Mahurangi of 453 kg/yr.

The Mahurangi Estuary is larger the Puhoi Estuary, however the majority of the sediment from the Mahurangi River is deposited within the upper estuary. Therefore when we are considering the deposition of contaminants discharged to the Mahurangi Estuary, it is more appropriate to consider the load of the Mahurangi River on its own, rather than as a proportion of the larger Mahurangi Estuary catchment.

When we compare the predicted Zinc load in the Mahurangi River to the TSS load in the urban parts of the Mahurangi catchment the Zinc load makes up 0.3% of the sediment load. When we compare the Zinc load to the TSS load in the urban part of the Puhoi catchment, it makes up 0.04% of the load, both estuaries are predicted to retain similar proportions of incoming sediment loads and have similar flushing times. Neither the Mahurangi nor Puhoi have elevated concentrations of Zinc in sediment in the existing situation. We expect the predicted increases in Zinc load and stormwater concentrations stormwater in both estuaries to result in only minor changes in Zinc concentrations in sediment in those parts of the estuaries where contaminants sourced from road run off are likely to deposit.

The predicted increase in Copper in both the stormwater concentrations at the River mouths and the contaminants loads predicted to be discharged to the estuaries, is very small. We expect the predicted increases in Copper load and stormwater concentrations stormwater in both estuaries to result in only minor changes in Copper concentrations in sediment in those parts of the estuaries where contaminants sourced from road run off are likely to deposit.

We expect that any long term change in sediment quality as a result of the project would be small to negligible in the estuarine receiving environments.

5.   Recommendations and conclusions

Two methods have been used to estimate the change in water quality predicted to occur at 2031 during the operational phase of the Project.

The CLM provides a catchment wide indication of the relative change in contaminant loads. This modelling illustrated the value of the proposed stormwater treatment devices, in particular for traffic that is currently served by road with curb and channel drainage only and with the Project, be treated by wetlands.

Existing freshwater quality has low concentrations of metals and TPH. The predicted increases to occur as a result of the project are only expected to result in very small increases in contaminant concentrations in freshwater receiving environments.

The contaminant concentration method used existing freshwater quality data and literature values of the concentrations of contaminants from road runoff. The results from this method also illustrate the value of the proposed stormwater treatment measures.

The results of the contaminant load modelling, when considered in conjunction with the existing sediment quality within the Puhoi and Mahurangi estuaries suggests an expected negligible or small change in the long term estuarine sediment quality as a result of the Project.

The results of the water quality analysis in this report will be used to inform the water quality assessment discussed in the Operational Water Assessment Report, the Freshwater Ecology Assessment Report and the Marine Ecology Assessment Report.

6.   References

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