TAURANGA COMPREHENSIVE STORMWATER CONSENT MONITORING – THE FIRST FIVE YEARS

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ABSTRACT

Tauranga City Council was granted a comprehensive stormwater consent in 2012 for the discharge of stormwater throughout Tauranga City. Conditions of consent require monitoring of stormwater quality and ecological values of freshwater and marine receiving environments. The aim of the monitoring is to identify sub-catchments with poor stormwater quality and adversely affected receiving environments to focus treatment and/or remediation effort. Contaminant trigger levels are identified within consent conditions including a condition requiring further investigation should trigger levels be exceeded over consecutive sampling events or in the same quarter over consecutive years.

The end of 2017 marked the completion of five years of monitoring which provided sufficient data to identify sub-catchments with stormwater quality and/or receiving environment issues.

Water quality data indicated contaminants exceeding trigger values and requiring further investigation at 25 monitoring sites (from a total of 41 sites) across 16 sub-catchments. Freshwater ecological assessments indicated at least one contaminant above trigger levels at 13 monitoring sites (from a total of 28 sites) and nine sites were categorised as having poor ecological values based on habitat values and macroinvertebrate and fish assemblages. Three marine receiving environment sites (from a total of 49 sites) recorded at least one sediment contaminant above trigger levels and three sites were categorised as having poor ecological values based on benthic invertebrate assemblage.

Sampling results have been used by Tauranga City Council to address sub-catchments with contaminant issues through the following remedial actions:

- Refine the monitoring programme;
- Investigative sampling;
- Pollution prevention audits;
- Stormwater mitigation (i.e. installation of stormwater treatment devices); and
- Habitat restoration.

The completion of five years of monitoring comes at an opportune time, coinciding with:

- Development of Tauranga City Council's environment strategy that includes focus on water quality and protecting/enhancing the natural environment;
- Start of a new Long-Term Plan cycle enabling funding for proposed mitigation; and

- Ability to collaborate with other programmes such as City Transformation and Parks restoration projects.

KEYWORDS

Consent Compliance, Pollution Prevention, Stormwater Quality, Stormwater Monitoring

PRESENTER PROFILE

Kieran is an ecologist in the Boffa Miskell team in Tauranga. He has over 7 years of experience working in terrestrial and freshwater ecology disciplines throughout New Zealand.

Radleigh has over 10 years of experience working in and around water quality. Initially in an environmental laboratory, then in a pollution prevention role investigating impacts on stormwater quality. His current role involves managing consents for stormwater and wastewater operations at Tauranga City Council.

1 INTRODUCTION

Stormwater from an urban environment can have a significant impact, not just on aquatic life within the receiving environment, but also on the social, cultural and economic values (Makepeace et al., 2009; Mallin et al., 2009). Urban environments are known to increase contaminants, such as nitrogen, phosphorus, copper, zinc and total suspended solids, entering receiving environments (Bedan & Clausen, 2009). There is an increasing need to protect and enhance stormwater quality as our understanding of urban waterways and the values that they provide improves (Makepeace et al., 2009).

Tauranga City Council was granted a comprehensive stormwater consent in 2012 for the discharge of stormwater throughout Tauranga City. Conditions of consent require monitoring of stormwater quality and ecological values of freshwater and marine receiving environments. The aim of the monitoring is to identify those sub-catchments with poor stormwater quality and adversely affected receiving environments to focus treatment and/or remediation efforts. Contaminant trigger levels are identified for stormwater quality parameters within consent conditions including a condition requiring further investigation should trigger levels be exceeded over consecutive sampling events or in the same quarter over consecutive years. Trigger levels are also provided for the water and sediment quality monitoring undertaken within the receiving environment.

The monitoring plan was developed in 2012 and implementation commenced in 2013. A review of the plan is provided for at the completion of five years of monitoring. The plan describes the required sample collection methods, monitoring parameters, timing of sample collection, sampling locations and reporting requirements.

The end of 2017 marked the completion of five years of monitoring which provided data to assist in identifying sub-catchments with stormwater quality and/or receiving environment issues.

This paper provides an overview of the monitoring results from the past five years of stormwater monitoring across Tauranga City’s 26 sub-catchments (Figure 1). The paper also describes the proposed remediation actions in response to sub-catchments which were identified as having poor stormwater quality and/or adversely affected receiving environments.

2 METHODS

Stormwater monitoring incorporates both stormwater discharge quality and the ecological values of receiving environments. Monitoring of receiving environments is further divided into freshwater and marine ecosystems. Stormwater quality monitoring occurs across all sub-catchments. The receiving environment of all but three sub-catchments are monitored for ecological values, the remaining three sub-catchments are completely piped with no surface waterways or marine sediment areas suitable for ecological sampling. Several sub-catchments are also influenced by land uses outside of Tauranga City Council's boundary where waterways flow in from adjacent land that is within the neighbouring council's jurisdiction. Monitoring is conducted along some boundaries to assess water quality and ecological values before the influence of stormwater from land use within Tauranga City.

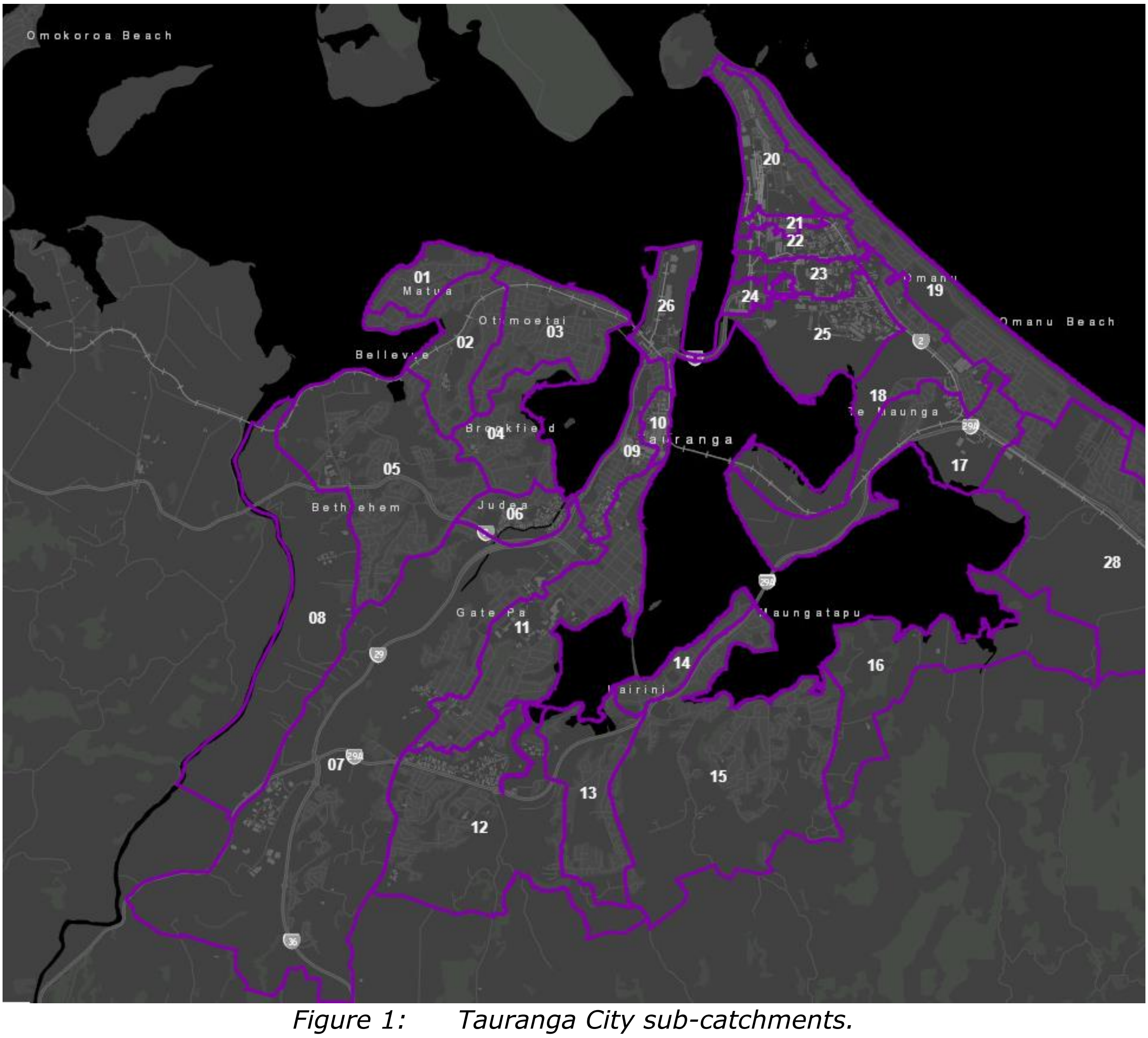

Figure 1: Tauranga City sub-catchments.

2.1 STORMWATER QUALITY MONITORING

Stormwater quality samples were collected from 41 sites over the past five years. At each site, water samples were collected on five separate occasions each year, including quarterly baseline samples and a single storm event sample. Baseline samples were collected from each site after a period of at least three days with no rainfall, while the storm event sample was collected within 24 hours of a less than one in ten-year rainfall event. In some instances, stormwater samples were not able to be collected due to lack of flow or saline intrusion at the sampling site.

Samples were sent to a IANZ accredited laboratory and analysed for pH, total suspended solids, total petroleum hydrocarbons, chemical oxygen demand, nutrients, heavy metals and E. coli. The results are compared against trigger values, which are identified in consent conditions. If a particular contaminant is found to exceed the trigger level over consecutive sampling occasions or in the same quarter over consecutive years, then further investigation of the contaminant source is required (repeated exceedances vs. isolated exceedances).

2.2 FRESHWATER RECEIVING ENVIRONMENT MONITORING

Ecological samples and data were collected from 28 freshwater receiving environment sites. The 28 sites were categorised as priority or non-priority sites based on which sub-catchments were anticipated to be "high risk" for contaminants. There were 18 priority sites monitored every two years and 10 non-priority sites monitored every five years. Sampling occurred after a period of at least three days with no rainfall. Priority sites have been monitored twice over the past five years while non-priority sites have been monitored once.

Freshwater monitoring included a fish survey, macroinvertebrate samples, site habitat values (i.e. habitat diversity, riparian vegetation, hydrologic heterogeneity, etc.), spot physio-chemical parameters (temperature, dissolved oxygen and pH) and other water quality parameters including total suspended solids, total petroleum hydrocarbons, chemical oxygen demand, nutrients and heavy metals. Trigger values for water contaminants have been identified in consent conditions.

2.3 MARINE RECEIVING ENVIRONMENT MONITORING

Ecological samples and data were collected from 49 marine receiving environment sites. Similar to the freshwater sites, marine sites were categorised as either priority or non-priority sites based on sub-catchments which were anticipated to be "high risk" for contaminants. Fifteen priority sites were monitored every two years and 34 non-priority sites monitored every five years. Priority sites have been monitored twice over the past five years while non-priority sites have been monitored once.

Marine monitoring included benthic invertebrate samples, analysis of sediment grain size and sediment contaminants (copper, lead and zinc). Sediment contaminant trigger values have been identified in the consent conditions.

2.4 REPORTING

Annual reports summarise the previous 12 months stormwater discharge quality and freshwater and marine receiving environment monitoring data. This incorporates assessment and interpretation of the collected data, and implications of the discharges on the receiving environment.

After five years, a monitoring report was produced summarising and interpreting/analysing all of the collected data. The five-year monitoring report covered; the effectiveness of the methods, trends in the data, proposed updates to the monitoring programme, identification of sub-catchments with poor stormwater quality and receiving environments, sub-catchments at risk and proposed mitigation measures to improve stormwater quality and ecological values in receiving environments. The annual and five-yearly reports were also used in consultation with iwi to communicate outcomes and assist with cultural management plan reviews. The five yearly report, along with consultation and engagement, will also inform the upcoming catchment management plan reviews.

3 RESULTS

3.1 STORMWATER QUALITY MONITORING

Over the past five years, at least one parameter exceeded its corresponding trigger value at 37 (across 25 sub-catchments) of the 41 sites (90%). Of the remaining four monitoring sites, no contaminants exceeded trigger values at two sites and monitoring ceased at the other two sites due to the construction of a road and associated infrastructure. Of the sites with exceedances, 25 sites (60%), across 16 sub-catchments, recorded repeated exceedances, requiring further investigation.

The type of parameters/contaminants which exceeded trigger values differed among sub-catchments and sites. Some sites had multiple parameter/contaminant exceedances. Table 1 provides an overview of exceedances. Zinc was the most common parameter/ contaminant to exceed trigger values, with 31 sites recording at least one zinc exceedance over the past five years. E. coli and copper were the next most prolific parameters/contaminants which exceeded trigger values at least once, with 23 and 22 sites, respectively.

Zinc was also the most common parameter/contaminant to repeatedly exceed trigger values with this occurring at 23 sites. Copper was the next most common parameter/contaminant with repeated trigger value exceedances, occurring at six sites.

Table 1: Number of monitoring sites that parameters/contaminants exceeded trigger values.

Parameter/ contaminant	Trigger values		Number of monitoring sites	
	Marine receiving environment	Freshwater receiving environment	Trigger value exceeded	Trigger value exceeded repeatedly
Chemical Oxygen Demand	250 g/m^3	250 g/m^3	7	2
Copper	8.0 μg/L	2.5 μg/L	22	6
E. coli	10,000 MPN	10,000 MPN	23	4
Lead	12.0 μg/L	9.4 μg/L	9	2
pH	≤ 6 – 9 ≥	≤ 6 – 9 ≥	4	0
Total ammonia	2300 μg/L	1700 μg/L	5	2
Total Petroleum Hydrocarbons	15 g/m^3	15 g/m^3	1	0
Total Suspended Solids	150 g/m^3	150 g/m^3	4	1
Zinc	43 μg/L	31 μg/L	31	23

3.2 FRESHWATER RECEIVING ENVIRONMENT MONITORING

Over the past five years, 13 of the 28 freshwater receiving environment monitoring sites (across nine of the 13 freshwater receiving environment sub-catchments) recorded a water quality parameter exceedance. Parameters/contaminants exceeding trigger values included copper, pH, nickel, nitrate, ammonia and zinc. Zinc was the most common parameter/contaminant to exceed its corresponding trigger level (eight sites), while copper was the next most common parameter/contaminant (five sites) (Table 2).

In addition to the water quality monitoring, nine of the 28 monitoring sites scored poorly in at least two of; habitat score, macroinvertebrate index and/or fish diversity.

3.3 MARINE RECEIVING ENVIRONMENT MONITORING

Over the past five years, a sediment quality parameter was exceeded at some point at three of the 49 marine receiving environment monitoring sites (two of the 20 marine receiving environment sub-catchments). Zinc was recorded above the trigger value at all three sites, and copper exceeded the trigger value at one site (Table 2).

In addition to the sediment quality monitoring, three of the 49 monitoring sites scored poorly for the number of taxa present within macroinvertebrate samples and Shannon-Weiner diversity.

Table 2: Number of receiving environment monitoring sites that parameters/contaminants exceeded trigger values.

Parameter/ contaminant	Freshwater		Marine	
	Trigger value	No. of monitoring sites to exceed value	Trigger value	No. of monitoring sites to exceed value
pH	≤ 6 – 9 ≥	2	-	-
Nickel	13 µg/L	1	-	-
Copper	1.8 µg/L	5	270 mg/kg (sed)	1
Zinc	15 µg/L	8	410 mg/kg (sed)	3
Nitrate	3400 µg/L	1	-	-
Total ammonia	1430 µg/L	1	-	-

4 DISCUSSION

4.1 STORMWATER QUALITY MONITORING

Approximately 90% of monitored sites have recorded at least one parameter which has exceeded the corresponding trigger value over the past five years. In addition, just over 60% of sites (across 16 of the 26 sub-catchments) have parameters which have repeatedly exceeded contaminant trigger levels, requiring further investigation. Whilst, parameters/contaminants exceeding trigger values vary across sites, zinc was the most common parameter/contaminant to exceed trigger values. Other contaminants which also commonly exceeded trigger values were copper and E. coli but these parameters were more often one-off occasions (i.e. trigger value was not exceeded repeatedly).

Zinc exceedances have been found widely across 25 sub-catchments within Tauranga City. At this stage, it is unknown why zinc is so prolific across the city nor the source(s) of the contaminant. Sub-catchments where zinc exceedances have been recorded include a variety of land use types such as residential (both new sub-divisions and more established parts of the city), commercial, industrial and rural (including both agricultural and horticultural land use). In other research, high zinc concentrations have been recorded in stormwater from catchments where there is a larger proportion of roofed area and which commonly featured zinc-galvanised iron roofing material (Brown & Peake, 2006). Zinc-galvanised iron is a common roofing material which can release zinc during rainfall (Gromaire-Mertz et al, 1999). Vehicle tyres have also been recognised as a contributor to zinc in stormwater (Kennedy & Sutherland, 2008). These are the likely sources for the high concentrations of zinc found within some Tauranga sub-catchments over the past five years of monitoring, however they are unlikely to be the only sources.

Other stormwater contaminants such as copper and lead are commonly found in catchments which have industrial land use (Brown & Peake, 2006) and are a likely source for some exceedances recorded from this monitoring. There are a variety of possible sources of E. coli. such as grazed rural environment, urban wildlife (particularly waterfowl) and cross contamination between stormwater and sewage (Marsalek & Rochfort, 2004). There are several sub-catchments which are influenced by rural areas outside of Tauranga City Council's boundary and are a likely source of E. coli. There are also numerous habitats for waterfowl across Tauranga sub-catchments which are connected to stormwater networks.

Some trends within the data are obvious and expected, such as repeated exceedances of multiple parameters/contaminants within high intensity land use sub-catchments (e.g. industrial). However, there are also sub-catchments with repeated exceedances where the sources are unknown at this stage. It is hoped further investigative sampling will provide a better understanding of contaminant sources.

4.2 RECEIVING ENVIRONMENT MONITORING

Non-point sources of pollution from urban runoff has been established as a major cause of degradation to the receiving environment (Tsihrintzis & Hamid, 1997). However, there are other factors which contribute to the impairment of urban waterways, including altered hydrology, modification of receiving environments (i.e. channel straightening and lining with artificial materials) and alteration of physio-chemical parameters such as temperature, dissolved oxygen and pH (Klein, 1979).

Ecological data collected from both the freshwater and marine receiving environments during the past five years indicated some sites had poor ecological values. These values are likely to be exacerbated by stormwater discharges, but are also likely related to habitat modification, fish passage barriers, and hydrodynamic environments.

Zinc exceedances were commonly recorded in freshwater receiving environment monitoring, although to a lesser extent compared to the stormwater quality monitoring. Just under 50% of freshwater receiving environment monitoring sites had a zinc exceedance at some point over the past five years. Although it should be noted that freshwater receiving environment monitoring is not as frequent as stormwater quality monitoring. Copper was also found to exceed trigger values at some sites, again drawing similarities with the stormwater quality monitoring.

Marine receiving environment monitoring found only 6% of sites recorded a zinc exceedance within the sediment at some point over the past five years. Zinc exceedances were less prolific within the marine environment compared to other monitoring. This could suggest that zinc entering the marine environment, from stormwater, is not being trapped in the immediate marine sediments and/or is being diluted in a larger receiving environment. This also raises the question as to whether monitoring marine sediments is a meaningful method for assessing stormwater quality and identifying issues within sub-catchments.

4.3 RESPONSE TO STORMWATER QUALITY MONITORING RESULTS

The sampling results are being used by Tauranga City Council to focus and prioritise future work on sub-catchments with contaminant issues. The following remedial actions form part of the next Long-Term Plan:

- Refine the Monitoring Programme to better represent the receiving environment, increase monitoring of stormwater discharges and remove redundant sites;
- Carry out investigative sampling to identify the specific areas of a sub-catchment, or particular properties, that are the source of contaminants;
- Undertake pollution prevention audits or site investigations where properties are known or found to be discharging stormwater with elevated contaminants;

- Installation of stormwater mitigation (e.g. raingardens, bio-swales, filtration devices, floating wetlands) where contaminant issues are well understood and where exceedances cannot be attributed to individual sites; and
- Carry out riparian enhancement and habitat restoration within open waterways to improve ecological values, and to protect existing values.

The completion of the first five years of stormwater monitoring comes at an opportune time for Tauranga City Council with:

- the formation of an Environment Committee and environment strategy for Tauranga City Council that includes a focus on water quality, and protecting and enhancing Tauranga's natural environment;
- the start of a new Long-Term Plan cycle enabling funding for proposed mitigation to be included; and
- the ability to collaborate with other programmes such as City Transformation and Parks restoration projects.

5 CONCLUSIONS

The purpose of the stormwater quality monitoring programme has been to identify which sub-catchments within Tauranga City have poor stormwater quality and to determine actual and potential effects of stormwater discharges on receiving environments. Numerous monitoring sites across Tauranga have been identified as having poor stormwater quality and/or adversely affected receiving environments. Zinc has been the most prolific contaminant, repeatedly exceeding trigger values across multiple sites and sub-catchments. The five years of monitoring has enabled identification of high priority sub-catchments, allowing Tauranga City Council to focus on current issues and incorporate potential prevention and mitigation options into catchment management plan reviews. Tauranga City Council has responded by planning remedial actions to improve stormwater quality and enhance receiving environments. Future monitoring will determine the success of the remedial actions as well as continue to identify "problem" sub-catchments.

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