Effects of Urban and Industrial Stormwater Discharges in the Hawke's Bay Region

State of knowledge report

November 2011

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EXECUTIVE SUMMARY

Discharges of stormwater in the Hawke's Bay Region are currently managed under the provisions of the Regional Resource Management Plan and the Proposed Regional Coastal Environment Plan.

As part of a wider review of its environmental policies, the Hawke's Bay Regional Council is reviewing its planning provisions relating to discharges of stormwater.

To contribute to this review process, the council has commissioned Aquanet Consulting Ltd to produce a "state of knowledge" report, summarising the information available on the location, nature and environmental effects of discharges of stormwater across the Hawke's Bay region, as of February 2011.

Types of stormwater discharges and types of receiving environment

This report covers the discharges of stormwater from urban and industrial/trade sources to any type of receiving environment, including land, unconfined aquifers, surface freshwater systems, estuarine/tidal systems and the coastal marine area. It does not cover discharges of stormwater from the roading network outside urban areas, or the stormwater runoff from rural (such as pastoral or forestry) land use.

Activity status and resource consent process

Stormwater discharges from urban areas and industrial and trade premises in the Hawke's Bay Region are either permitted or controlled activities under the RRMP and proposed coastal Plan. The Hawke's Bay Regional Council currently administers 107 individual resource consents for controlled stormwater discharges, including 74 for discharges from individual trade or industrial premises, and 33 from urban areas. Most urban stormwater catchments in the Napier City and Hastings District are subject to existing resource consents, and resource consent applications and pre-applications are being progressed for the Central Hawke's Bay, Napier City Council and Wairoa District main urban centres. The Hawke's Bay Regional Council has also engaged in a process aiming at identifying the remaining trade or industrial premises that would require resource consent for their stormwater discharges.

Location of stormwater discharges

Stormwater is generally discharged near the catchment where it is generated, so by definition, the greatest concentration of stormwater discharges from urban and industrial discharges occur near the main urban and industrial centres. Of the main freshwater and estuarine systems, the Ahuriri Estuary is by far the system that has the greatest proportion (13%) of its surface catchment occupied by built-up areas. The Clive/Karamu river catchment is the only other main surface water system where built-up areas occupy a more than minor proportion of its catchment (4.2%).

Stormwater contaminants

Stormwater-associated contaminants are typically metals/metalloids, hydrocarbons, sediment, bacteria, and nutrients. A number of studies undertaken either in relation to specific resource consent processes, or as part of wider projects provide valuable information on the presence and levels of these contaminants in the stormwater systems and in the receiving environments.

The contaminant levels in stormwater discharges and in stormwater collection and transport network is also relatively well characterised. Typically, most metals and metalloids tested for are detected, but only copper, lead, and, most predominantly, zinc are generally present at elevated concentrations. Polycyclic Aromatic Hydrocarbons (PAHs) are often detected when analysed, sometimes at concentrations exceeding environmental guidelines. Lastly, nutrient concentrations, in particular DRP, appear to be a common feature of many urban stormwater discharges.

Contaminants in receiving environments

The background levels, i.e. the levels of contaminants in the context of the current general rural land use but in the absence of direct influence of urban or industrial stormwater discharges, are relatively well characterised for the different types of aquatic environment in the region and are supported by background levels obtained in other regions of New Zealand. These provide very valuable benchmark values, enabling the early detection of contamination (i.e. well before it breaches environmental guidelines). The present report provides a compilation of such information (Table 4).

Estuaries represent the downstream receiving environments of the freshwater drainage network and are sensitive to the same effects of land-use activities as streams and rivers throughout the catchment. The monitoring information available in estuaries often shows that the influence of stormwater discharges on contaminant concentrations is generally measurable, and can be widespread at a whole system scale. For example, metal concentrations in the wider Ahuriri Estuary sediment appear to be more elevated than the regional background levels.

Contaminant concentrations in excess of environmental guidelines have been identified at sites located in close proximity to stormwater outlets in the Ahuriri Estuary and the Napier Harbour (Iron Pot). However, such exceedances of environmental guidelines appear to be generally confined to areas directly affected by significant point-source stormwater discharges, thus the risk of actual effects on aquatic biota, signalled by guideline exceedances, is likely to be localised. Contaminant concentrations at sites distant from stormwater outlets generally remain below environmental guidelines, with the notable exception of the Iron Pot, where monitoring has indicated extensive petroleum hydrocarbon contamination by petroleum hydrocarbons (heavy fuels).

Based on monitoring information available regionally, it appears that significant metal contamination can be found in predominantly residential catchments, sometimes at levels similar to those found in industrial catchments (Strong, 2005b). This seems to be at odds with the operative and proposed regional planning framework, which distinguishes between stormwater discharges from residential (permitted) and industrial/trade (controlled) areas. Given the potential implications of such finding, it is suggested that this point be examined further.

In freshwater receiving environments, there appears to be very limited direct information to support an effective assessment of effects of stormwater discharges on aquatic life. However, studies with a wider scope have shown that urban streams generally have poor to very poor aquatic communities, much poorer than comparable streams with a predominantly rural catchment (Stansfield, 2009a) The degree of imperviousness in the catchment (a measure of urbanisation) was found to be a key driver (Stansfield, 2009b).

Information gaps

There is currently little specific information on the characteristics or effects of the stormwater discharges from the region's largest urban and industrial areas (i.e. Hastings District urban areas). This is a significant gap given that stormwater from these catchments is collected by a network of small, low gradient streams, which converge to a tidal estuary. The bundle of consents recently granted to Hastings District Council requires some monitoring, which will in effect address parts of this information gap. However, the resource consent conditions do not appear to contain specific provisions relating to the monitoring of stormwater-related contaminants in the lower Clive River and/or the Waitangi Estuary.

Temporal patterns, in particular temporal trends in relation to stormwater contaminant levels in both stormwater discharges and receiving environment (i.e. are contaminant levels getting better or worse?) do not appear to have been studied in the Hawke's Bar Region, probably due to a lack of consistent time series.

Although it was largely outside the scope of this report, very little information specific to the Hawke's Bay Region could be found on the characteristics or effects of stormwater from the roading network. One report, prepared in support of the resource consent application for the Napier airport stormwater discharges, identifies that the stormwater from the adjacent highway may contribute as much contaminants to the South-eastern wetland as the airport area (MWH, 2010b). One of these discharges (from the roading network) is permitted under the operative planning framework; the other (airport, a trade/industrial premise) is controlled under. It is suggested that the potential for stormwater discharges from roads and highways outside the urban areas be investigated, particularly in relation to the vulnerability of the different types of receiving environment, to support the development of the future policy framework. Work undertaken in other regions in New Zealand could be used as a basis for this investigation.

There does not appear to be any information relative to the assessment of the potential effects of stormwater discharges to unconfined aquifers. Most resource consents allowing such discharges require no or very limited monitoring.

Recommendations

Monitoring results suggest that stormwater from predominantly residential areas could lead to significant metal contamination of downstream systems, possibly similar to those resulting from predominantly industrial catchments. Given the potential implications of such finding, it is suggested that this point be examined further. In particular, it is suggested that the composition of the urban land use/zoning in the catchment above each monitoring site could be determined and used as a variable in a statistical analysis of monitoring results available region-wide.

Given the demonstrated presence of contaminants in the receiving environments, it is strongly recommended to pursue a regular monitoring programme (SoE) to identify temporal trends at system/catchment level.

The Waitangi Estuary constitutes the final receiving environment for the largest urban and industrial stormwater catchment in the region. There does not appear to be any monitoring information relating to the degree of contamination of this estuary by stormwater-borne contaminants, and this information gap does not appear to be addressed by the consent conditions associated with the stormwater discharges from the Hastings District urban areas. It is recommended that some monitoring, such as sediment quality monitoring, be undertaken in parts of the Waitangi Estuary that are directly influenced by the Clive River inputs. The investigation could initially be targeted to the main contaminants of concern identified elsewhere in the region, i.e. metals (in particular zinc, copper and lead) and PAHs.

The risk of effects due to stormwater discharges is likely to depend on the type or sensitivity of the receiving environment. For example, a small low-gradient stream or a and/or highly depositional part of an estuary are likely to be more at risk from a local accumulation of persistent contaminants brought by stormwater, than, say, a large, fast flowing/gravel bottom river, or a high energy coastal environment, where dilution and dispersion of contaminants are evidently much greater. It is suggested that any assessment of effects of stormwater discharges should initially include an appraisal of the sensitivity of the receiving environment as well as the nature of the discharge.

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To contribute to this review process, the council has commissioned Aquanet Consulting Ltd to produce a "state of knowledge" report, summarising the information currently available on the location, nature and environmental effects of discharges of stormwater across the Hawke's Bay region.

1.2. Aim and scope of the project

1.2.1. Aim

The aim of this report is to identify the information and data currently available on the effects of discharges of stormwater in the Hawke's Bay region, and summarise it in a "state of knowledge report".

In particular, this report seeks to identify:

- The types of stormwater discharges in the Hawke's Bay Region;
- The types of environments receiving stormwater discharges, such as coastal ecosystems, freshwater ecosystems and land;
- The nature of contaminants and the nature and scale of environmental effects associated with discharges of stormwater;
- The details of information sources currently available;
- A summary of this information;
- A description of the limitations and gaps of this information.

1.2.2. Scope

This report covers the discharges of stormwater from urban and industrial/trade sources to any type of receiving environment. It does not cover discharges of stormwater from the roading network outside urban areas, or the stormwater runoff from rural (such as pastoral or forestry) land use.

This report focuses on effects of stormwater discharges on the water and sediment quality and ecology of the receiving environment, but it does not address issues associated with hydrology or engineering matters, such as flooding and/or erosion risk.

This report specifically focuses on data and information from within the Hawke's Bay Region, available as of February 2011.

1.2.3. Terminology

There appears to be a certain amount of debate among stakeholders of the management of stormwater discharges in the Hawke's Bay Region relating to the status of urban waterways, in particular the smaller "drains" or "streams" that flow within urban areas. These are sometimes called drains, and considered as a conduit of stormwater discharges to the receiving environment. However, the same waterways may also be considered as streams in their own right in some situations. This debate is by no means specific to the Hawke's Bay Region.

The scope of the present report is essentially to present existing information as accurately as possible. It is not within scope to provide an assessment or opinion regarding the above debate. The approach taken in this report is to generally use the term "waterway" when referring to urban "drains" or "streams". When specifically referring to a waterway in particular, the approach taken is to use the same appellation (e.g. "drain" or "stream") and status (i.e. "receiving environment" vs. "stormwater system") as in the existing consent documents. For example, in relation to the discharge of stormwater from part of the Napier City urban area to the Ahuriri Estuary, the Ahuriri Estuary is considered the receiving environment, with the Purimu Drain considered as part of the stormwater system. It is important to note that this approach does not constitute an assessment or an opinion with regards to the appropriateness of this status.

1.3. Report outline

This report is made of six main sections. Section 1 above provides some general background and scope for this report. Section 2 below outlines the regional planning framework for the discharges of stormwater in the Hawke's Bay Region. Section 3 describes the nature and location of the main receiving environments for discharges of stormwater that fall within the scope of this report, i.e. from urban areas and industrial/ trade premises. Section 4 provides an overview of the management of stormwater discharges. Section 5 summarises the monitoring information sourced and used for the production of this report. Lastly, Section 6 provides a summary of findings, identifies information gaps and provides recommendations for future work.

2. Regional planning framework

2.1. Regional Resource Management Plan

Under Hawke's Bay Regional Resource Management Plan (RRMP), discharges of stormwater to land or freshwater are permitted or controlled activities (Rules 42 and 43 respectively).

RRMP Rule 42 generally permits the discharge of stormwater to land or water, unless the discharge is specifically excluded. For the matters covered in this report, it means that stormwater discharges to land or water from residential urban areas are permitted under this rule, as long as they do not result in specific flooding/erosion or the production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials in any receiving water body after reasonable mixing. Stormwater discharges draining areas containing industrial or trade premises of more than 2 ha in size, or used for the storage of hazardous substances are specifically excluded from Rule 42. All other stormwater discharges (i.e. not permitted under Rule 42) have a controlled status under rule 43, provided controlled matters are complied with. Controlled matters include:

> *"All reasonable measures shall be taken to ensure that the discharge is unlikely to give rise to all or any of the following effects in any receiving water after reasonable mixing:*
>
> *i. The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials.*
>
> *ii. Any conspicuous change in the colour or visual clarity.*
>
> *iii. Any emission of objectionable odour.*
>
> *iv. The rendering of fresh water unsuitable for consumption by farm animals.*
>
> *v. Any significant adverse effects on aquatic life."*

Discharges that do not comply with the provisions of either of these rules then default to Rule 52, which places a discretionary status on the activity.

The RRMP provisions relating to stormwater are currently being reviewed by the Regional Council. As part of the process, the Regional Stormwater Working Group, made of representatives of the regional council and the region's Territorial and Local Authorities (TLAs) was set out to build agreement on "How stormwater should be managed in the Hawke's Bay Region" The Working Group is in particular developing a Regional Stormwater Strategy. The strategy will, amongst other things, assist in informing the direction and philosophy for reviewing the RRMP's stormwater provisions and proposing plan change. One of the reasons for commissioning this report is to help inform this review process.

Of note, are the policy provisions applying to the protection of groundwater quality in areas of unconfined aquifer. The Heretaunga Plains aquifer system is the most significant groundwater resource in the Hawke's Bay and the RRMP sets an Objective (Objective 21) of:

> *"no degradation of exiting groundwater quality in the Heretaunga Plains and Ruataniwha Plains aquifer systems".*

The RRMP Objectives identify that the risk of contamination of the Heretaunga Plains aquifer system arises from a number of activities, including *"(e) stormwater discharges"*. The RMMP Objectives (Objectives 21 and 22) and also seek to protect groundwater quality of the Ruataniwha Plains unconfined aquifer and any other unconfined or semi-confined aquifer, but do not specifically identify stormwater as being a key source of contamination.

Policy 16 provides for the regulation a number of activities, including stormwater discharges into or onto land over the Heretaunga Plains and Ruataniwha Plains unconfined aquifers. As will be identified later in this report, a number of urban and industrial/trade areas discharge stormwater to land overlying the Heretaunga Plains unconfined aquifer (refer to Section 3.1).

RRMP Policy 17 also requires the preparation and implementation of site management plans and spill contingency measures for relevant activities in areas of high contamination vulnerability for the Heretaunga Plains aquifer system.

2.2. Proposed Regional Coastal Environment Plan

Rules 24 and 25 of the Proposed Regional Coastal Environment Plan (RCEP) provide a rule framework similar to that of rules RRMP 42 and 43 for discharges of stormwater in the Coastal Margin. Small scale discharges (defined as from a catchment not containing industrial and/or trade premises of more than 2ha in size and not containing industrial or trade premises used for the storage of any hazardous substance) are permitted under Rule 24. Discharges that do not meet the requirements of rule 24 are controlled activities under Rule 25. Discharges not complying with conditions/standards/terms in Rule 25 become discretionary under Rule 9.

Discharges of stormwater into the coastal marine area (CMA) are subject to different rules in the RCEP. Diversion and discharge of stormwater into the CMA is generally a permitted activity (rule 154), subject to some exclusions. If Rule 154 does not apply, then the diversion and discharge is subject to Rule 155 as a restricted discretionary activity[1] if all conditions/standards/terms can be complied with. If all conditions/standards/terms are not met, then the diversion and discharge of stormwater to the CMA is a discretionary activity under Rule 153.

[1] RCEP Rule 155 is currently subject to appeal and so is not yet operative.

2.3. Urban Stormwater

Urban stormwater is generally managed by territorial and local authorities (TLAs), i.e. district and city councils. They generally manage urban stormwater collection networks, and the discharges from these networks into the receiving environments. The discharge of stormwater from most urban catchments in the Hawke's Bay Region is subject to resource consents from the Regional Council. One notable exception to this general rule is the discharge of stormwater from parts Napier City to the Ahuriri Estuary (Purimu and GPC[2] Drainage systems), for which the Napier City Council and HBRC's operations department are joint consent holder.

Resource consent applications for stormwater discharges from the main urban centres in the Hawke's Bay Region either have been recently granted or are in the process of being considered (Table 1).

A number of city and district councils across New Zealand have promulgated stormwater bylaws to regulate the discharge of stormwater into the stormwater network they manage. In the Hawke's Bay Region, the Hastings District Council and the Central Hawke's Bay District have stormwater bylaws.

The Hasting District Council (HDC) bylaw forms part of the council's water services bylaw 2009. It identifies High Risk Facilities (HRF), which are required to hold a conditional stormwater consent from HDC to discharge stormwater into the SWNI[3]. Premises that have the potential to breach the acceptable stormwater characteristics are also subject to the same requirements. The bylaw stipulates that the owner or occupier of such premises may be required to regulate the quantity or quality of the stormwater discharge (e.g. install pre-treatment). The bylaw also defines stormwater discharge characteristics, including prohibited, conditional and permitted characteristics.

The Central Hawke's Bay District Council (CHBDC) stormwater bylaw 2008 contains provisions relating to the entry of contaminants into the public stormwater drainage network, in particular it stipulates that no person shall allow any material, hazardous material, chemical, rubbish, litter or other substance into the public stormwater drainage network. The bylaw also requires approval from the Council to make connection to the public stormwater drainage network; it does not however require resource consent from the District Council for the discharge of stormwater to the public network, or specifically identify acceptable stormwater quality limits and/or the possible need for pre-treatment.

To the author's knowledge, Napier City Council and Wairoa District Council do not currently (as of February 2011) have specific stormwater bylaws.

2.4. Industrial Stormwater

Stormwater from trade and industrial sites basically fall into two categories:

- Where the stormwater is discharged into the urban stormwater collection network, it becomes part of the urban stormwater, managed by (and therefore under the responsibility of) the local district or city council. Where applicable, these discharges may be regulated by the TLA's bylaws, as described above;
- Where the stormwater is discharged directly from the site into a natural receiving environment (i.e. land or water), the discharge is managed by the site owner or occupier, with an activity status determined by regional rules as detailed above.

[2] George Drive/Plantation/County drains
[3] Stormwater Network Infrastructure

Table 1: Summary of the resource consent status of the main urban stormwater discharges in the Hawke's Bay Region.

TLA	City/town	Receiving environment	Status
Central Hawke's Bay District	Waipukurau	Tukituki River	Consent application to be lodged in 2011
	Waipawa	Waipawa River	Consent application to be lodged in 2011
Hastings District Council	Hastings, Havelock North, Clive and Flaxmere	Clive River and tributaries	15 resource consents, authorising the discharge of stormwater from 15 individual catchments, granted May 2010 Expire May 2022
	Specific areas	Land/ Heretaunga unconfined aquifer	Three consent applications lodged September 2010
Napier City Council	Napier urban area (Purimu/GPC Drains)	Ahuriri Estuary	Resource consent jointly held by the city and the regional councils Granted November 2002, Expires June 2018
	Napier urban area (Burns Road catchment)	"Iron Pot" (Napier harbour)	Granted October 2007 Expires May 2022
	Napier urban area (Tyne Street Drain catchment)	Ahuriri Estuary	Two resource consents Granted November 1989, Expire September 2026
	Napier urban area (Taipo Stream)	Ahuriri Estuary	Three separate consents Granted 2003, expire 2013, 2023 and 2038
	Napier urban area (Cross Country Drain)	Coastal marine Area	Granted July 2006 Expires May 2027
	Napier urban area (Tyne/Thames catchment)	Ahuriri Estuary	Consent Application to be lodged in 2011
	Napier urban area (Central Business District)	Coastal Marine Area	Consent Application to be lodged in 2011
Wairoa District Council	Wairoa	Wairoa River	Scoping report submitted in July 2010 Application to be lodged in 2011

3. Type and location of receiving environments of stormwater discharges in the Hawke's Bay Region

3.1. Location of stormwater discharges

Self-evidently, urban stormwater is generated in urban areas and industrial stormwater where industrial activity is located. In practical terms, this translates into a very heterogeneous spatial distribution of the stormwater discharges across the region, with the vast majority of discharges, both in terms of number of resource consents and of surface area drained by the discharges, located near the main urban and industrial centres of Napier and Hastings.

As a result, the receiving surface aquatic environments located at close proximity to Napier (Ahuriri Estuary/Napier Harbour and its tributaries) and Hastings (Clive River and its tributaries) receive by far the most stormwater discharges (in numbers and in stormwater catchment areas) both from the general urban areas, and from individual trade or industrial premises. Further, the Clive River forms a common estuary with the Ngaruroro and Tutaekuri Rivers, the Waitangi Estuary. As a result, this estuary ultimately receives stormwater discharges from the three catchments, which includes the Hastings, Flaxmere, Havelock North and Clive urban areas, a small part of Napier City, and a number of discharges from trade or industrial (22 to water and 20 to land, Table 2).

Table 2: Location of urban and industrial stormwater discharges in the Hawke's Bay Region by surface water catchment. Urban areas are based on GIS data analysis provided by HBRC. Discharge numbers from industrial and trade premises include both current discharge permits and resource consent applications or pre-applications being processed as of January 2011, based on HBRC consents database.

Surface Catchment		Urban area			Industrial/trade
Name	Total area (ha)	Main Urban Centres	Area (ha)	% of total catchment	N. of discharges
Tukituki	250,522	Waipawa, Waipukurau	603	0.2%	To land: 3 To water: 2
Ahuriri Estuary	14,564	Ahuriri Lagoon tributaries	114	0.8	To land : 0 To water: 7
		Napier Drains	1,375	9.4	
		Napier South	101	0.7	
		Taipo	331	2.3	
		TOTAL	**1,921**	**13.2%**	
Tutaekuri River	83,105	Napier South	75	0.09%	To land: 0 To water: 3
Ngaruroro River	201,246	-	1.1	<0.01%	To land: 8 To water: 0
Clive/Karamu River	51,492	Hastings Streams	825	1.6%	To land: 12 To water: 19
		Havelock Nth Streams	355	0.7%	
		Irongate-Southland	664	1.3%	
		Karamu – Clive Corridor	157	0.3%	
		Mangateretere	<0.1	<0.01%	
		Muddy Creek	16	0.03%	
		Paritua-Karewarewa	11	0.02%	
		Poukawa	4.7	<0.01%	
		Raupare	128	0.25%	
		TOTAL	**2,160**	**4.2%**	
Esk	26,785	-	12	0.05%	To land: 1 To water: 1
Mohaka	243,946	-	4.3	<0.01%	To land: 1 To water: 0
Wairoa	367,032	Kouhauroa	8.7	<0.01%	To land: 0 To water: 1
		Waikaretaheke	16.2	<0.01%	
		Wairoa Corridor	342	0.09%	
		TOTAL	**366**	**0.1%**	
Lake Waikaremoana	35,163	-	-	<0.01%	To land: 0 To water: 1
Lake Whakamarino	1,532	-	-	<0.01%	To land: 0 To water: 1
Open Coast	N/A	Napier (Cross Country Drain)	1,100	N/A	To land: 3 To water: 2

Of the main freshwater and estuarine systems, the Ahuriri Estuary is by far the system that has the greatest proportion (13%) of its surface catchment occupied by built-up areas. The Clive/Karamu river catchment is the only other main surface water system where built-up areas occupy a more than minor proportion of its catchment (4.2%) (Table 3).

In comparison, catchments with a much lesser degree of development, such as the Mohaka and Esk catchments receive only a very small number of stormwater discharges. Similarly, the catchments of Lake Waikaremoana and Whakamarino only receive one consented stormwater discharge each.

A total of 15 resource consents are also held or being applied for discharges of stormwater to land over the Heretaunga unconfined aquifer.

3.1. Receiving environment types

As of February 2011, a total of 118 individual resource consents have been identified, including consents currently held, or in the process of being applied for, for discharges of stormwater from urban, industrial or trade sources in the Hawke's Bay Region. Table 3 summarises the number of resource consents for discharges into the main different types of receiving environments.

Overall, over two thirds (85consents, 72%) of the resource consents authorise direct discharges to aquatic environments (freshwater or coastal water), with less than one third (33 consents, 28%) going to land. In particular, most discharges of stormwater from urban areas are operated directly to surface water environments, the only exception being parts of Hastings urban areas where the stormwater is discharged to land overlying the Heretaunga unconfined aquifer.

More than one third of the 35 consented discharges to land are to land overlying the Heretaunga Plains unconfined aquifer, where specific regional policy provisions apply (refer to Section 2.1).

Table 3: Type of receiving environment of urban and industrial stormwater discharges in the Hawke's Bay Region by surface water catchment. Data source is HBRC consents database. Numbers include both current discharge permits and resource consent applications or pre-applications being processed as of January 2011.

Receiving environment		Urban stormwater		Industrial/trade
Type	Sub-type	Urban Centre	N of consents	N. of consents
Coastal	Wetland/ Estuary/Harbour	Napier	4	5
	Open coast	Napier	2	1
Surface Freshwater	Drains	Hastings, Flaxmere, Esk, Napier	9	18
	Streams and rivers	Napier Hastings Havelock North Clive Wairoa Waipawa Waipukurau Private subdivisions	22	22
	Lakes and wetlands	-	0	2
Land	Over unconfined aquifer	Hastings	3	12
	Others	-	0	18

4. Management of Stormwater discharges

4.1. Urban stormwater

4.1.1. Current Management

Hastings District Council (HDC) has promulgated stormwater bylaws, which primarily aim at managing the quality of stormwater before it enters the public network. In particular, it identifies acceptable stormwater characteristics for discharge into the network, and requires resource consent for High Risk Facilities, and any other property that may exceed acceptable stormwater characteristics. The bylaw also clearly identifies that the owner or occupier may be required to control the quantity and quality of its discharge. It is understood by the author that HDC does not undertake specific treatment of stormwater once it has entered the public stormwater network, apart from primary screening (gross solids) and standard grit traps.

A stormwater contamination and response protocol (SRP) has been established between HDC and HBRC, since April 2000 (McBryde, 2010) to coordinate the two organisations' response in the case of an emergency or accidental spill of contaminants in urban streams or the stormwater network. HBRC has powers to take action over contamination incidents (issue abatement orders and prosecutions). Since the adoption of the Water Services Bylaw (2009), Hastings District Council has similar powers and can withdraw the stormwater service provided to the property if it considers the discharge from the property is not under proper control (McBryde, 2010).

The Central Hawke's Bay District Council (CHBDC) stormwater bylaw does not contain specific provisions relating to the quality or treatment of stormwater within its network. Apart from general provisions relating to the entry of any contaminant or hazardous substance "that cause or is likely to cause nuisance" into the public stormwater network, the CHBDC stormwater bylaw does not appear to require or enable control over the quality of stormwater entering the public network. CHBDC does not currently have any information on stormwater treatment that may be undertaken on individual sites, and does not currently undertake any specific stormwater treatment (Nicola Foran, pers. comm.).

Stormwater from the Napier urban areas does not undergo specific treatment apart from gross screening and grit traps, although the passage through the open drains of the Napier city stormwater network (e.g. Purimu and GPC drains) may allow trapping of contaminated sediments (Ataria, 2008).

Wairoa District Council currently does not have an operative stormwater bylaw, and does not undertake any stormwater treatment. Gross solid screening appears to be absent in Wairoa township (EMS 2010).

In conclusion, based on the information available in the documentation associated with the processing of resource consents (e.g. hearing evidence, consent applications or pre-applications), public stormwater networks in the Hawke's Bay Region appear to involve variable infrastructure types (piped, channelized, road side swales and drains, et.) and generally include screens to prevent gross solids from entering the network, except in Wairoa Township (EMS 2010). Sediment/grit traps are also understood to be a common feature of public stormwater networks. Other than this basic level of primary treatment, stormwater does not appear to currently receive any additional treatment after it has entered the public network, and before its discharge to the receiving environment. One council (Hastings District council) has promulgated a relatively strong bylaw, enabling some control over the quality of the stormwater from individual sites before it enters the public stormwater network.

4.1.2. Foreseeable future

The regional Stormwater Working Group is tasked with the development of a Regional Stormwater Strategy, a draft of which was produced in February 2010. The draft Strategy "provides a framework from which to address a range of water quantity and quality, and environmental protection issues in a

coordinated, integrated and prioritised manner". The goal for stormwater management, as set by the draft Regional Stormwater Strategy (February 2010) is:

> *"Stormwater in the Hawke's Bay Region is managed by comprehensive, catchment based, Stormwater Management Plans that optimise the protection of people, property and culture, sustains ecosystems while efficiently supporting economic activity"*

Whilst this strategy is still a draft and is not yet official council policy, it still represents a common view shared in-principle by a number of regional stakeholders, and is likely to guide, at least to some extent, the management of stormwater in the region.

The recent (2010) resource consent process that authorised the discharge of stormwater from most of HDC's urban areas to surface water drains and streams[4] resulted in the imposition of a comprehensive set of consent conditions that will have a major bearing on stormwater management in that area. In particular, conditions require the identification of sites that do not comply with the HDC 2009 stormwater bylaw, and the establishment of a timetable to bring any non-compliant sites to a compliant status. Conditions also require the development of detailed stormwater catchment management plans (CMP). The CMP are to be developed for each of the 15 sub-catchments and determine the best practicable option for managing flooding, stream erosion, contaminant discharges and receiving environment quality. The development of CMP is to be based on modelling of contaminant loads, and sediment, water quality and biological monitoring. The conditions also impose that HBRC's recent Stormwater Management and Low Impact Design guidelines[5] be implemented in significant new developments, and encouraged in existing areas.

The CMP approach was first imposed in New Zealand by the Auckland Regional Council and is now commonly used for TLA asset management planning and regional council consent decision-making. HBRC and Napier City Council have jointly expressed their intention to develop CMPs for the Napier urban area.

Resource consent applications for other urban areas are currently being processed by HBRC (e.g. areas of Napier, Waipawa, Waipukurau, and Wairoa). The outcome of these processes will determine the stormwater management regime within these areas.

4.2. Stormwater from industrial or trade premises

The Hawke's Bay Regional Council administers 74 resource consents authorising the discharge of stormwater from trade or industrial premises directly to a receiving environment. There are an additional 4 resource consents currently being applied for. It is understood that discharges of stormwater from industrial or trade premises that do not currently hold a consent from the Regional Council but may require one are in the process of being identified and addressed by HBRC. The remainder of the trade/industrial premises discharge to the stormwater networks, in turn managed by the TLAs, but very limited information appears to be available from the TLAs at this stage.

The management of stormwater quality from individual sites generally relies on prevention and management of on-site activities, to prevent, as much as possible, the entry of contaminants into the stormwater system in both "normal" and "accidental" (e.g. spills) situations. This often translates into consent conditions requiring the implementation of a number of stormwater "good management practices", such as site management plans, emergency procedures, bunding of areas used for the storage/use of hazardous substances, and site-specific measures. To protect the groundwater resource, RRMP policy 17 also requires the preparation and implementation of site management plans and spill

[4] A bundle of 15 individual consents, DP090355W to DP090369W.

[5] Hawke's Bay Regional Council Waterway Guidelines: Low Impact Design (May 2009) and Stormwater Management (May 2009).

contingency measures for relevant activities in areas of high contamination vulnerability for the Heretaunga Plains aquifer system.

Notwithstanding the implementation of good on-site stormwater management practices, treatment of stormwater prior to its discharge is sometimes required to avoid, remedy or mitigate potential adverse effects on the receiving environment. Based on the information held in the HBRC's consents database and provided in the consent documents, it appears that 32 (40%) of these discharges have a treatment device in place. Interestingly, the proportion of discharges to water that are treated is essentially the same (41%). The proportion of discharges to land over the unconfined aquifer that are treated is higher (7 out of 12 consents, or 58%).

There are a number of ways and a large variety of off-the shelf devices that can be used to adequately treat stormwater, ranging from sediment ponds, constructed wetlands, grass swales/buffers, interceptors, oil/water separators, etc… The nature and design of the treatment system put in place should be determined based on the discharge quality and quantity characteristics, the nature and sensitivity of the receiving environment and site-specific conditions. Accordingly, the treatment systems currently in place to treat stormwater discharges in the Hawke's Bay vary widely.

5. Monitoring information

This section presents the main documents reporting environmental monitoring data and information relating to stormwater discharges in the Hawke's Bay Region. The monitoring information contained in each document is briefly summarised, to provide the source and context of the information synthesised in Section 6 of this report.

5.1. Consent monitoring

A large proportion of the monitoring data and information available in the Hawke's Bay Region was collected as part of the resource consent process. Section 5.1.1 below summarises the information provided to the regional council as part of resource consent applications. Section 5.1.2 summarises the "compliance" monitoring information, i.e. the monitoring that is undertaken pursuant to resource consent conditions during the "life" of a resource consent.

5.1.1. Monitoring undertaken as part of the consenting process

5.1.1.1. Discharge of the Burns Road-Ahuriri catchment (Napier City) into the Iron Pot (EAM)

The consent application for the discharge of stormwater from the Burns Road–Ahuriri catchment to the "Iron Pot" (Figure 1) was supported by an assessment of environmental effects (AEE) prepared by EAM (Smith, 2007). The AEE involved the taking and analysis of stormwater and sediment samples. Composite samples of the "first flush" (3 first hours of rainfall) and of the remainder of the storm event were analysed for a suite of typical urban stormwater contaminants: total Suspended Solids (TSS), Arsenic (a metalloid), metals (cadmium, chromium, copper, nickel, lead, mercury and zinc), total Petroleum Hydrocarbons (TPH), and Polycyclic Aromatic Hydrocarbons (PAHs). Sediment samples were analysed for texture, the same metals and metalloids, TPH and PAH.

Stormwater results indicate:

- All metals but mercury were detected;
- Concentrations of copper, lead and zinc well in excess of the ANZECC guidelines 95% (25, 4 and 36 times higher respectively);
- TPH detected (275 ppb);
- 5 individual PAH detected, but at low concentration (<0.1 ppb);

Sediment results indicate:

- All metals/metalloids were detected in the sediment;
- Only zinc exceeded the ISQG-low (but not the ISQG-high);
- Copper and lead were measured at concentrations approaching, but not exceeding the ISQG-low guidelines;
- High concentration of petroleum hydrocarbons in the C15-C36 band, indicative of heavy fuel oils were detected at both sampling sites;
- Twelve individual PAH compounds were detected, but at concentrations not exceeding the ISQG-low guidelines;
- Overall the results indicate some localised contamination as a result of the stormwater discharge. However, this contamination is limited to the area immediately surrounding the outfall and does not appear to have extended further into the Iron Pot, apart from heavy fuel oil.

5.1.1.2. Discharge of stormwater from other parts of the Napier City urban area

The author understands that consent applications are being prepared for discharges of stormwater from parts of Napier City that do not currently hold discharge permit, in particular the Thames/Tyne Street Drains, which discharge to the Ahuriri Estuary and the central business district, which discharges to the coast. However, no monitoring information was available at the time of writing this report.

Some other parts of the Napier urban area may fall under the provisions of RRMP Rule 42, i.e. be permitted. In particular, the author understands that the status and resource consent requirements of the discharge of stormwater from the Napier CBD area are currently being discussed between Napier City Council and HBRC.

Figure 1: Aerial photograph of the Burns Road – Ahuriri Stormwater catchment (purple outline). From Smith (2007).

5.1.1.3. Discharge of the Napier Airport into the South East Wetland

Stormwater from the entranceway, the carparks and buildings of the Hawke's Bay Airport are currently discharged with limited pre-treatment to an extensive tidal wetland, the South-eastern Wetland, hydrologically connected to, and forming part of, the Ahuriri Estuary. An Assessment of Effects including stormwater (discharge) and receiving environment water and sediment quality was prepared in support of the resource consent application (MWH, 2010a), and resource consent was recently granted. The resource consent conditions include requirements for an upgrade of the stormwater treatment systems. Monitoring results indicate:

- All metals were detected in stormwater samples (both first flush and post-first flush samples). Total zinc, copper and lead concentrations in some stormwater samples exceeded the 95% protection level ANZECC trigger values;
- Total metal concentrations in the receiving environment's water column were generally low, although total copper and zinc exceeded the ANZECC (2000) 95% protection level trigger values and total lead exceeded the 99% protection level ANZECC trigger value on one occasion;
- Total Suspended Solids concentrations were highly variable in stormwater samples (3 to 1,000 mg/L), and moderate in the receiving environment;
- Dissolved nutrient (DIN and DRP) concentrations were variable in the stormwater (0.05 to 0.7 mg/L for DIN and <DL[6] to 0.24 mg/L for DRP), and moderately elevated in the receiving environment (0.02 to 0.8 mg/L for DIN and 0.012 to 0.110 mg/L for DRP);
- In sediment, all metals were detected, with lead and zinc exceeding the ISQG-low (but not the ISQG-high) values in the stormwater system (i.e. ponds and drains). Sediment metal concentrations in the receiving environment were all below the ISQG-low values;
- Ten individual PAH compounds were detected in sediment samples of the stormwater system, four of them exceeding the ISQG-low values;
- Nine individual PAH compounds (subset of the ten compounds detected in the stormwater systems) were detected in sediment samples from the receiving environment, three of which exceeded the ISQG-low values (the same three compounds also exceeded ISQG-low values in sediment samples from the stormwater system).

5.1.1.4. Discharge of stormwater from the Waipukurau and Waipawa urban areas to the Tukituki River

Stormwater from the Central Hawke's Bay towns of Waipukurau and Waipawa is currently discharged to the Tukituki and Waipawa rivers (Figure 2 and Figure 3). The assessment of environmental effects has yet to be completed and lodged with the Regional Council, but Central Hawke's Bay District Council have kindly made monitoring information available for the purpose of this report. Data relate to water and sediment quality monitoring undertaken within the stormwater collection/discharge system (i.e. generally surface stormwater drains) between August 2010 and January 2011. Results indicate:

- Dissolved cadmium and mercury were almost never detected in water samples; copper and zinc were always detected in water samples. About half the samples exceeded the ANZECC (2000) guidelines 95% level protection trigger values;
- DRP was generally elevated. Nearly all of the samples exceeded the RRMP guideline (0.015 mg/L) and 75% of the samples were more than 8 times the RRMP guideline (0.122 mg/L);
- In sediment, only copper and zinc were analysed. Both metals were always detected. With regards to zinc, about 70% of samples exceeded the ISQG-low trigger value and about half exceeded the ISQG-high value. Copper concentrations were relatively less elevated, with less than 10% of samples exceeding the ISQG-low trigger value, and none exceeding the ISQG-high trigger value.

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[6] Detection Limit

Figure 2: Stormwater sampling locations in Waipawa, Central Hawke's Bay District (source: Nicola Foran, Opus International Consultants Ltd).

Figure 3: Stormwater sampling locations in Waipukurau, Central Hawke's Bay District (source: Nicola Foran, Opus International Consultants Ltd).

5.1.2. Monitoring undertaken during the life of the consent (compliance monitoring)

The HBRC consent database contains 107 current discharge permits for discharges of stormwater to land, freshwater or coastal water. A small number of consents require that relatively extensive monitoring be undertaken and reported back to the Regional Council. A summary of monitoring data is presented below for each of these consents. However, the vast majority of resource consents do not require extensive monitoring:

- 58 (54%) of resource consents do not require any form of stormwater discharge or receiving environment monitoring;
- 24 (22%) only require limited monitoring of the discharge quality (no more than four times per year, limited list of determinands);
- The remaining 25 consents (23%) require more comprehensive monitoring, generally involving receiving environment monitoring (water quality, sediment quality and/or biological monitoring). It should be noted that these 25 consents include the bundle of 15 consents granted to Hastings District Council in 2010, and covering stormwater discharges from the vast majority of the district's urban areas.

When considering the consents by activity type, it becomes apparent that:

- Most consents authorising stormwater discharges from significant urban areas into aquatic environments require relatively extensive monitoring. Monitoring requirements generally include metals, organic contaminants and TSS in the stormwater discharges and the receiving environment. Some also require biological monitoring (e.g. algal or macroinvertebrate communities) in the receiving environment;
- Monitoring requirements associated with individual trade/industrial premises vary widely, as could be expected, depending on the size of the site, the type of activity, and the nature of the receiving environment. For example, petrol stations are typically required to measure TPH in discharge, whilst quarries are generally required to measure determinands associated with sediments (typically Total Suspended Solids). These monitoring requirements are summarised in a table presented in Appendix B).

5.1.2.1. Discharge of the Burns Road-Ahuriri catchment (Napier City) into the Iron Pot

Conditions of Consent CD070023W, for the discharge of stormwater from the Burns Road–Ahuriri catchment to the "Iron Pot" require the taking of 6-hour profile of metal contaminants in the stormwater discharge. Results (presented in Appendix F) indicate that:

- Nickel and chromium were generally not detected;
- Arsenic and cadmium were detected in about half the samples, and only a moderate concentrations;
- Lead was detected in all samples, but at concentrations generally below the ANZECC 95% protection level trigger value;
- Zinc and copper concentrations in all samples exceed the ANZECC 95% protection level trigger value by a wide margin. This result is consistent with those obtained previously (refer to 5.1.1.1);
- Zinc concentration seemed to increase during the 6 hour period. Copper concentrations were generally higher during the second half of the 6 hour monitoring event.

5.1.2.2. Discharge of stormwater from the Purimu and GPC drainage systems to the Ahuriri Estuary (Napier City)

Consent CD990516W authorises the discharge of stormwater from part of the Napier City urban area (Purimu and GPC drainage systems), requires that 4-yearly benthic surveys of sediment composition and quality and ecology of the Ahuriri Estuary be undertaken. The first two surveys were available at the time of writing this report, undertaken in 2006 (Bennett, 2006) and 2010 (Smith, 2010). These surveys were undertaken at two sites near the discharge points and one "reference" site near the railway bridge (Figure 4). It is interesting to note that the reference site for these surveys is virtually the same as one of the sites (site A) in the estuarine monitoring programme undertaken by HBRC (Madarasz-Smith, 2006).

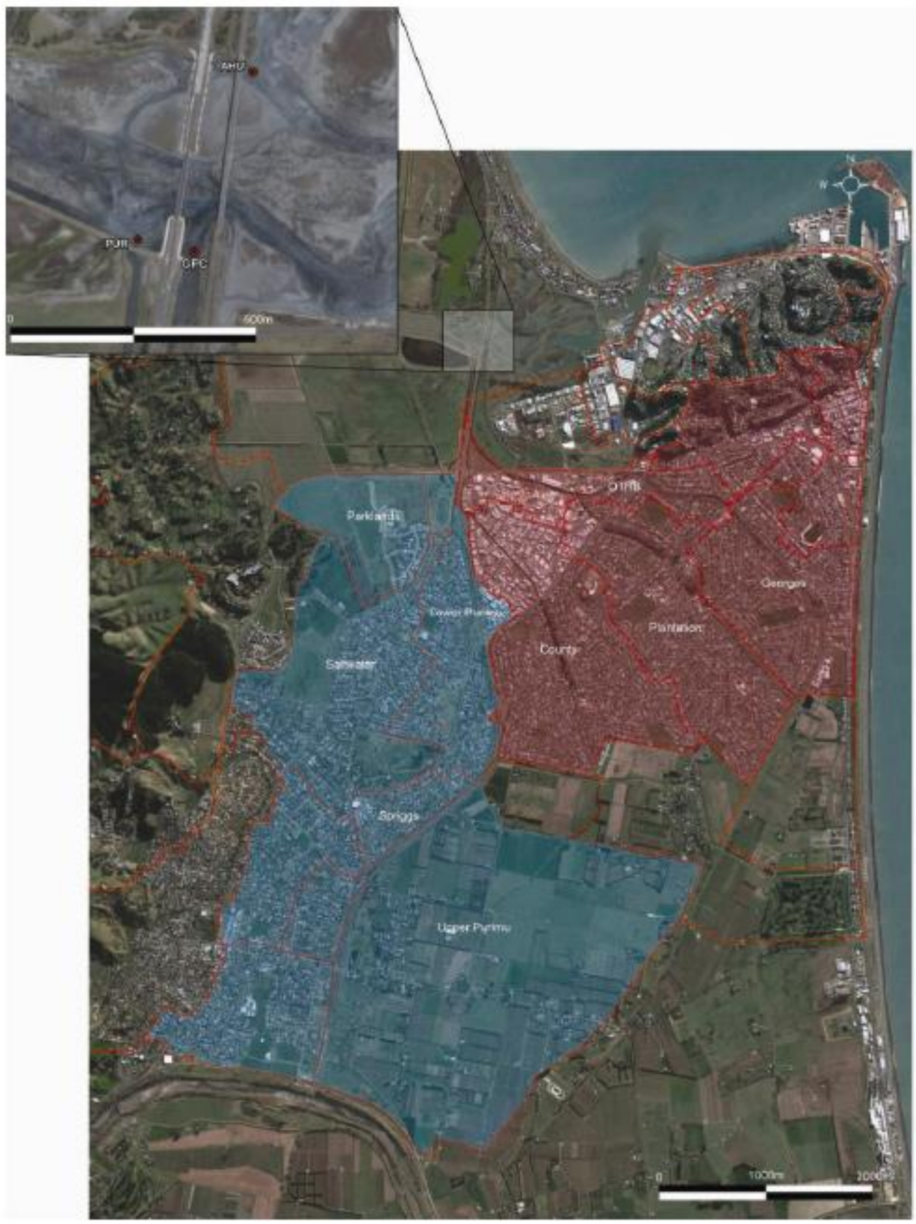

Figure 4: Aerial photograph of Napier City Stormwater catchments. The Purimu catchment (shaded in blue) and the Georges Drive/Plantation/County (GPC) drainage systems discharge into the Ahuriri Estuary. The inset shows the location of the benthic survey sampling sites for the consent compliance monitoring programme, representing the Purimu discharge site (Site PUR), the GPC discharge site (GPC) and a reference site adjacent to the railbridge (Site AHU). (Source: Smith, 2010).

- Both "impact" sites showed some signs of organic enrichment with dense patches of a potentially nuisance macroalgae at both sites, and hydrogen sulphide odour at one of the sites (Smith, 2010);
- In 2006, there were no distinct trends of trace metal enrichment at the two "impact" sites (Bennett, 2006);
- In 2010, mean metal/metalloid concentrations at both "impact" sites were higher than at the "reference" site, but remained below the ISQG-low trigger value (except for zinc at the GPC site). The GPC site had generally higher mean metal/metalloid concentrations than the Purimu site. Mean zinc concentrations in sediment were between the ISQG-low and ISQG-high trigger values at one of the impact sites (GPC);
- Organic matter and nutrients were more elevated at the "impact" sites compared with the "reference" site in 2010. In 2006, only the GPC site presented significantly higher nutrient concentrations than the "reference" site;
- The proportion of fine sediments seemed to have increased at all sites between 2006 and 2010, with the proportion of silt and clay higher at the two "impact" sites compared with the "reference" site;
- Macrobenthic communities tended to structure according to sediment texture and to a lesser extent organic matter. As a result, fine sediment tolerant species were more abundant in 2010 than in 2006, and were more abundant at the "impact" sites than the reference site in 2010;
- Overall benthic environment at both "impact" sites showed evidence of being negatively influenced by the stormwater discharge, but the magnitude of effect remains moderate (Smith , 2010).

5.1.2.3. Port of Napier

The Port of Napier holds resource consent (CD040033Wa) to discharge stormwater from its installations to coastal waters. The consent document identifies a number of discharge points and stormwater catchments, and the consent conditions require monitoring at (stormwater discharge quality), or near (sediment and receiving water quality), five of these outlets. 2009 and 2010 monitoring results were assessed by HBRC[7], as summarised below:

- In first flush stormwater samples, pyrene and phenol were detected;
- In non-first-flush stormwater samples, copper and zinc largely exceeded the ANZECC trigger values. In particular, zinc was reported to be excessively high for non first-flush samples, even when compared with first-flush samples;
- Dissolved nutrient levels, DRP and nitrate-nitrite nitrogen (NNN), were also excessively high in stormwater samples , approximately 1 to 2 orders of magnitude above the ANZECC guidelines;
- Metal concentrations in the sediments were below ANZECC (2000) guidelines ISQG-low, indicating that adverse effects may be expected rarely. It was noted (Madarasz-Smith, 2010) that metal concentrations in sediment near three out of five monitored outlets were elevated compared with regional background levels;
- Four individual PAH compounds were detected, all below ANZECC (2000) guidelines ISQG-low, indicating that adverse effects may be expected rarely. It was noted that two PAH compounds were approaching the ANZECC (2000) guidelines ISQG-low trigger values;
- TPH and SVOCs (other than the PAHs above) in sediment were below detection limits;
- In receiving water samples, dissolved nutrient levels in excess of the ANZECC guidelines were measured in the receiving waters, in particular DRP;
- Copper was also measured in excess of the ANZECC guidelines at two of the four receiving environment monitoring sites.

[7] Memo by Anna-Madarasz-Smith, dated 14 June 2010, file reference CD040033Wa.

5.1.2.4. Cross County Drain Stormwater monitoring results

Coastal Permit N. CD960274Wc requires that water quality be sampled once per quarter at three points of the Cross County Drain. Only one set of monitoring results, from samples taken in March 2010 was provided for this report. Results are presented in Appendix E.

Results indicate that total cadmium, lead and chromium concentrations were either below the detection limits or below the ANZECC (2000) guidelines (95% protection level) trigger values.

Most other results were also below detection limits, but the detection limits used for the other metal analysis of were quite high, i.e. higher than the ANZECC (2000) trigger values, making the results difficult to interpret. It is strongly recommended that future analysis be undertaken with detection limits below the relevant guidelines.

5.1.2.5. Future monitoring requirements

A number of operative resource consents require, as part of their conditions of consent, that monitoring be undertaken in the future.

For example, and as signalled previously, the bundle of resource consents recently granted to HDC impose a significant amount of investigation, monitoring and development of catchment management plans. On a smaller scale, the discharge permit recently (2011) granted to Hawke's Bay Airport Ltd also contains some limited monitoring requirements. Other resource consents also require on-going monitoring.

The intention here is not to detail these future monitoring results but to signal that a significant amount additional monitoring data will become available in the foreseeable future, which should be used to update the conclusions and summaries provided in this report.

5.2. Other monitoring

5.2.1.1. Clive River and urban stream catchments water quality, 2009 SoE report (HBRC)

This report (Stansfield, 2009a) presents the results of water quality and ecology monitoring undertaken by HBRC at a number of sites on the Clive River and its tributaries, as part of their State of the Environment (SoE) monitoring programme. Results and conclusions are summarised below:

- There are no point-source discharges in these catchments, apart from stormwater discharges;
- All monitoring sites have macroinvertebrate communities in poor to very poor condition;
- All monitoring sites present elevated DRP concentrations, with very poor compliance with the RRMP guideline (0.015 mg/L);
- Most sites have good rates of compliance with the RRMP suspended solids guideline;
- Total hydrocarbon concentrations in sediment were tested once in 2006 and found to be below detection limits at all sites;
- Dissolved metal (copper, zinc and lead) generally comply with ANZECC trigger values, except in the Ruahapia Stream, where the zinc guideline is never complied with. The report identifies industrial activities in the Ruahapia catchment as the likely source of zinc contamination.

5.2.1.2. Urban Streams of the Napier Catchment (HBRC)

This report (Stansfield, 2009b) presents a summary of the water quality and macroinvertebrate community index monitoring information available at 13 urban stream sites within the Napier urban area as of December 2009. The report indicates that:

- urban streams are significantly more polluted than rural streams, and urban streams with higher impervious land cover in their catchment have poorer water quality;
- stream sites within, or downstream of, industrial areas show regular non-compliance with the zinc environmental guideline in the water column;
- other urban streams show exceedances of the same zinc environmental guideline, but generally only following wet weather;
- macroinvertebrate communities of urban streams are in poor health when compared with rural streams;
- percent imperviousness in the stream catchment (a measure of urbanisation) was a fundamental driver of aquatic macroinvertebrate community structure, with decreases in sensitive macroinvertebrate taxa and instream and riparian biodiversity being associated with and increase in the percentage of imperviousness in the catchment.

5.2.1.3. *Ahuriri environmental assessment (HBRC)*

An environmental assessment of the Ahuriri Estuary's sediment and ecology was undertaken by the Hawke's Bay Regional Council, involving the sampling of sediment and an assessment of flora and fauna at three sites Ahuriri environmental assessment and monitoring (Madarasz-Smith, 2006).

Results indicate:

- detectable metals (lead, zinc, cadmium, chromium, copper and nickel) in the sediment, but at concentrations well below sediment quality guidelines (ISQG-low);
- Metal concentrations (normalised to 100% fines) were within the range of concentrations observed in other New Zealand estuaries, although zinc appeared to be at the high end of the range;
- Nitrogen and phosphorus appeared to be within the range of concentrations observed in previous studies in the Ahuriri estuary;
- Fauna composition appeared to be strongly driven by sediment composition;
- Benthic macroalgae were uncommon.

5.2.1.4. *Environmental Assessment of Ahuriri and Porangahau Estuaries (HBRC)*

As part of its Estuarine Ecology Programme, HBRC has undertaken environmental monitoring of the Porangahau and Ahuriri Estuary since 2006.

The surveys show generally low levels of metal contamination in the sediments, except at one site in the Ahuriri Estuary, adjacent to the Tyne Street Drain outlet. Metal concentrations at this site were higher than at the other sites within the survey. Zinc concentrations exceeded the ISQG-low trigger value, and lead and chromium were close to reaching their respective ISQG-Low trigger value.

Macroinvertebrate fauna composition was found to be primarily driven by sediment composition, in particular the proportion of fine sediment. The site adjacent to the Tyne Street Drain outlet had different faunal composition from that of the other sites, but the difference could not be ascribed to the higher metal concentrations and could be explained by the difference in sediment composition.

5.2.1.5. *Metal concentrations in sediments from the Purimu and County stormwater drains (EAM)*

This short report presents the results of an investigation into the concentration of metals in sediments from the Purimu and County stromwater drains and their suitability for land disposal (EAM, 2005). The Purimu Stream has a largely residential catchment and the County Drain is influenced by industrial activities. Monitoring results indicate:

- When compared with regional background concentrations, arsenic, copper, lead and zinc were elevated at both sites. In addition, cadmium, chromium and nickel were also elevated at the County Drain site;

- Zinc exceeded the 2000 ANZECC ISQG-low trigger value at both sites, and exceeded the ISQG-high value at the County Drain site;
- Lead concentrations exceeded the ANZECC (2000) ISQG-low (but not the ISQG-high) trigger value at the County Drain site.

5.2.1.6. Backckground metal concentrations in sediments (Strong 2005a- MSc thesis)

This Masters of Science Thesis is base on an extensive, region-wide field study of metal concentrations in sediments of all major estuarine and lagoon systems in the Hawke's Bay Region, as well as of the riverine systems that feed into them. It provides very useful information on the background concentrations in each system.

The thesis concludes:

- Overall, the metal concentrations are low in estuarine and lagoon sediment, generally well below the ANZECC (2000) ISQG-low trigger value. Only one result, from the Clive River, exceeded the ISQG-low trigger value for zinc;
- The Ahuriri Estuary presents the highest degree of sediment metal contamination in the region, a fact largely attributable to the stormwater inputs from Napier City;
- With the exception of the Ahuriri Estuary, the other sites sampled have similar concentrations to other estuarine systems also largely influenced by pastoral land-use;
- Trace metal concentrations in the sediments of estuarine systems were similar to those of the riverine systems that feed into them.

5.2.1.7. Stormwater Sediment Quality (Strong, 2005b)

This report, prepared by EAM on behalf of Hawke's Bay Regional Council provides results of sediment quality monitoring undertaken at three sites receiving stormwater from a rural, a residential and an industrial catchment respectively, to characterise typical trace metal contamination in these situations. The results indicate:

- Low sediment trace metal concentrations in the rural catchment, well below the ANZECC guidelines (ISQG-Low). these results, along with others reported from previous studies, are useful in characterising "background" metal concentrations in the Hawke's Bay;
- Significantly more elevated metal concentrations were found in the sediment of both the residential and industrial catchments;
- The residential catchment presented metal concentrations between 2 and 25 times higher than the background. In particular, arsenic, copper, lead and zinc exceeded the ANZECC (2000) guidelines;
- The industrial catchment also presented metal concentrations between 3 and 25 times higher than the background. In particular, chromium, copper, lead and zinc exceeded the ANZECC (2000) guidelines;
- Interestingly, metal concentrations in the residential catchment were similar to (cadmium, copper) or higher than (arsenic, mercury, lead, zinc) those of the industrial catchment (except the chromium concentrations that were approximately 10 times higher in the industrial catchment).

5.2.1.8. Health Assessment of Napier Estuary (Landcare Research report)

This report (Ataria *et al.*, 2008) presents a vision plan and health assessment of the Napier (Ahuriri Estuary), and as such has a wide scope, including partnership development, literature review as well as actual monitoring. Only the monitoring aspects are reported below. This report presents in particular results of monitoring of a range of stormwater contaminants in sediment and edible tissue samples of cockles and flounder, as well as the use of a biomarker of exposure to PAHs (EROD activity). Monitoring results indicate:

- Zinc concentrations exceed the regional background level at four of the seven Ahuriri Estuary sites sediment samples;
- Lead, cadmium and mercury regional background levels were exceeded at two of the seven sites. All other metal concentrations were within regional background levels;
- One site, adjacent to the Tyne Street drain outlet into the estuary, presented elevated concentrations (compared with the regional background level) of all 5 metals analysed. Zinc and lead concentrations exceeded the ISQG-low trigger value. No metal concentration exceeded the ISQG-high trigger values;
- PAH concentrations in sediments were below the guidelines at all sites except the site adjacent to the Tyne Street Drain outlet. At this site, PAH concentrations were orders of magnitude higher than at any of the other sites, and individual compounds generally exceeded the ISQG-low trigger values, although only one compound exceeded its ISQG-high trigger value (Dibenzo[a,h] anthracene);
- Organochlorine pesticides and polychlorinated biphenyls (PCBs) were either not detected or present at very low concentrations;
- Low levels of metal contaminants were found in the flesh of shellfish (cockle) and fish (yellowbelly flounder);
- Biomarkers (EROD activity) indicated flounder exposure to PAHs in the Ahuriri Estuary ;
- Fish diversity in the Ahuriri Estuary appeared to be similar to that of 20 years ago.

6. Stormwater contaminants and environmental effects

6.1. General information

6.1.1. Nature, Source and pathways of stormwater contaminants

In developed areas, an increase in impervious surfaces, such as buildings, roads, driveways and car parks increases runoff, and decreases the soakage of rainfall into the ground. This runoff collects any contaminants in its path, carrying them to the receiving environment. These contaminants are typically hydrocarbons, sediment, bacteria, metals and metalloids and nutrients (GHD, 2005), but any other contaminant can be transported by stormwater if stored, used or placed where it can run off into surface water runoff.

The contaminants can originate from:

- general activities in residential areas (e.g. gardening, car washing, painting, sanding, etc.);
- localised activities in commercial and industrial areas;
- vehicle and tyre wear and exhaust emissions, deposited on roads during dry weather and picked up by stormwater;
- galvanised roofs, a significant source of zinc in urban areas.

Stormwater can affect receiving environments by the contaminants it transports, but also by its own physical characteristics, in particular pH and temperature.

6.1.2. ANZECC Guidelines and effects on biota

Most studies referred to in this report compare their monitoring results with existing environmental guidelines. In particular, metal and organic micro contaminants (particularly PAHs) concentration, in the water column and in sediments, are generally compared with the ANZECC (2000) guidelines trigger values.

The numerical limits provided in the ANZECC (2000) guidelines are "trigger values", and concentrations in excess of these trigger values do not necessarily mean that a significant adverse effect has occurred, or will occur.

The water quality trigger values for water column toxicants (Table 3.4.1 of the guidelines) "represent the best current estimates of the concentrations of chemicals that should have no significant adverse effects on the aquatic ecosystems" (ANZECC, 2000, Section 3.4.3). The sediment quality guidelines (ISQG-low and ISQG-high) trigger values often referred to in this report represent a statistical probability of effects. The water column and sediment guidelines are based on two different approaches, but are both associated with the risk of effects rather than demonstrable, actual, effects.

The ANZECC (2000) guidelines provide a risk-based decision scheme for applying the guideline trigger values. The process is summarised in Figure 3.4.1, p 3.4-14 of the document. Basically the process recommends comparing the expected contaminant concentration with the default trigger guideline value. If the expected contaminant concentration is below the guideline, this indicates a low risk of significant adverse effects on the aquatic ecosystems. If the contaminant concentration exceeds the guideline, this indicates a potential risk, and the guideline trigger values should be reviewed in the light of site specific factors and/or a site-specific guideline should be calculated. If the site-specific guideline is still exceeded, the ANZECC framework recommends that either further investigations in the risk of effects (e.g. direct toxicity assessments) or remediation action be undertaken.

6.2. Contaminant levels in stormwater systems

A number of studies, particularly those related with resource consent processes for stormwater discharges provide information on the levels of contaminants within the stormwater collection and transport networks, and stormwater discharges.

It is noted that the status of a number of open surface water drains and small streams within urban areas is unclear, as they appear to be sometimes considered as drains, i.e. part of the stormwater network, and sometimes as streams, i.e. part of the receiving environment. This is particularly the case for a number of waterbodies within the Napier and Hastings urban areas. The approach taken in this report is to follow the consent documents, as explained in Section 1.2.3.

Information relative to concentrations of contaminants in water and sediments stormwater systems is summarised in Table 4. The large open drain systems that drain parts of Napier (e.g. GPC, Purimu and Tyne Street Drains) were considered as freshwater stormwater systems.

Results indicate that most metals are often detected in both stormwater and sediment within the stormwater networks. Arsenic, cadmium, chromium, nickel and mercury are present at relatively low concentrations, generally below environmental guidelines. Zinc, lead and copper are often measured at concentrations well in excess of environmental guidelines.

Interestingly, sediment metal concentrations in stormwater drains in residential areas appear to be similar to, or higher than, those measured in predominantly industrial catchment, although this comparison is directly provided in only one available study (Strong, 2005b).

The presence and concentration of petroleum hydrocarbons and PAHs in stormwater discharges was found to be highly variable, but with exceedances of environmental guidelines on occasions.

One interesting feature is that DRP concentrations were generally found to be elevated within urban stormwater systems, generally several times above the RRMP guideline (0.015 mg/L).

It is important to note that exceedances of environmental guidelines within stormwater systems should however not been seen as a direct indication of environmental effects, as environmental guidelines should be applied to receiving environments (i.e. after reasonable mixing).

6.3. Background contaminant levels in the environment

6.3.1. Water and sediment

A relatively large number of studies can be used to provide an indication of the "background" concentration of various contaminants in different compartments of the aquatic environment. The "background" levels are here considered as being the levels currently expected to occur in the absence of direct contamination from industrial of urban stormwater, but in the context of historical and current agricultural land use in the catchment (which is different from "pristine" or "natural" background levels).

A number of studies were directly aiming at establishing background contaminant levels. For example, Strong (2005a) provides very useful information about the concentration of metals in sediments in estuarine systems across the whole region, and in freshwater systems that feed into them. Ataria et al. is the only study found that provides some, albeit limited, information on the background concentrations of a range of organic micro-contaminants, including PAHs, organochlorine pesticides and PCBs.

The results of investigations into the effects of stormwater discharges can also sometimes provide useful information on the background contaminant levels in the different systems, for example when "upstream" or "reference" sites are used as part of the study.

Information relative to background concentrations of contaminants in water and sediments of freshwater and coastal systems is presented in the genral summary table presented at the end of this report (Table 4).

Overall, results indicate low levels of background metal contamination, similar to comparable systems in New Zealand, except the Ahuriri Estuary, where slightly higher background concentrations of most metals are found throughout most of the estuary (Strong, 2005). PAHs, organochlorine pesticides and PCB concentrations at one upper estuary site (used as reference site in the study) Ahuriri Estuary were found to be below detection limits, or very low – in any case well below environmental limits (Ataria *et al*., 2008).

6.3.2. Living biota

Only two studies were found to contain monitoring information on the presence of stormwater-related contaminants in biota (fish and shellfish) from the Ahuriri, Porangahau (Aratia *et al*., 2008) and Wairoa Estuaries (NIWA, 1998).

Metal concentrations were found to be low in both fish and shellfish flesh from these three estuaries, well below the tolerable dietary uptake guidelines for human consumption.

No information was available on the concentration of contaminants in freshwater living organisms.

6.4. Contaminants in receiving environments

The concentrations of stormwater-related contaminants in environments receiving stormwater discharges were measured as part of a range of studies reviewed for the preparation of this report. Two types of sites were distinguished: those that are directly affected by stormwater discharges in close proximity (e.g. directly outside the zone of reasonable mixing in studies related to resource consents) and those that are within systems that receive significant stormwater discharges, but well away from the actual outlets or zone of reasonable mixing. Results available from the studies reviewed for the preparation of this report are summarised in Table 4.

6.4.1. Freshwater

In a pattern that is consistent with what is observed in stormwater systems, metals in freshwater receiving environment are often detected in samples of both water and sediments. Concentrations of cadmium and mercury were not found to exceed any environmental guidelines, and concentrations of arsenic and nickel were found to be low or, on rare occasions at levels similar to the ISQG-low guidelines in sediments of

directly affected receiving environments (close proximity). Chromium was also found to be below detection limits in the water column, but was found at concentrations close to the ISQG-high trigger values (i.e. exceed ISQG-low by a wide margin) at some sites directly affected by stormwater discharges ("close proximity").

Copper and lead and zinc were found to exceed environmental guidelines in both water and sediment at some of the "close proximity" sites. Zinc appears to be the most prominent contaminant at sites directly affected by stormwater discharges, both in terms of the number of sites that exceed the guidelines and in terms of the magnitude of the exceedances (up to several time the ISQG-high trigger value at some sites).

There is only limited information on the presence of organic contaminants in the water column and sediment of freshwater receiving environments. What limited information there is shows that individual PAH compounds have been measured in sediments of receiving environments, sometimes at concentrations exceeding the ISQG-low trigger values (but not ISQG-high). In the same study, PAHs were not detected in water samples.

6.4.2. Estuaries and harbours

Of the two main estuarine systems that receive discharges of stormwater from significant urban areas, only one has been the subject of sufficient investigations to provide a reasonably robust picture of contaminant distribution: the Ahuriri Estuary. The other, the Clive/Waitangi Estuary, receives stormwater from most of the Hasting district's urban centres, but virtually no receiving environment contaminant data appear to be available.

Metal concentrations in sediments over most parts of the Ahuriri Estuary appear to be more elevated than in other estuarine systems across the region and nationally (Strong, 2005a). However, several studies have shown that metal concentrations in this estuary are generally below environmental guidelines, except at sites that are directly affected by significant point-source discharges of stormwater (e.g. Aratia *et al.*, 2008). At some of these sites, concentrations of lead, copper and nickel were found to exceed the ISQG-low trigger values, but not the ISQG-high. Zinc was once again found to be the metal of greatest environmental concern, with concentrations often near, or in excess of, the ISQG-low guidelines and sometimes in excess of the ISQG-high guidelines. Zinc was also found at the ISQG-low concentration at one site not directly affected by a stormwater discharge ("distant" site). Other metals (cadmium, chromium and mercury) and metalloids (arsenic) were not found to exceed environmental guidelines, even at directly affected sites.

Similarly, PAHs concentrations in the Ahuriri estuary were found to be low, except at the one site within that study that is directly affected by a point-source stormwater discharge. At that site, several individual PAH compounds exceeded ISQG-low and ISQG-high trigger values.

The Iron Pot presents evidence of significant heavy fuel and total PAHs contamination at both "close" and "distant" monitoring sites, although no individual PAH compounds were found to exceed their respective environmental guideline. Lead, copper, and even more so zinc, contamination of this area was also evident close to the stormwater outlet, but dropping to near or below ISQG-low guidelines at the distant site.

The information sourced and reviewed for the purpose of this report did not provide any evidence of PCB or organochlorine pesticides contamination, although information is very limited. Neither did it provide evidence of metal accumulation in fish or shellfish, even in the Ahuriri Estuary, which was found to present overall elevated metal concentrations compared with the regional background levels.

Evidence of PAH metabolites and exposure biomarkers were found in the bile of fish taken from the Ahuriri Estuary.

6.4.3. Open coastal environment

There appears to be very limited information on contaminant levels in the open coastal environment. The only study reviewed related to the discharge of stormwater from the Port of Napier, the results of which are summarised in 5.1.2.3. Sediment samples taken near stormwater outlets indicated that metal concentrations were elevated compared with regional background levels, but still below ISQG-low trigger values, indicating that adverse effects may be expected rarely. Similarly, some PAH compounds were detected, but at concentrations below the ISQG-low trigger values.

Water samples taken immediately outside the mixing zones indicated elevated nutrient levels (particularly DRP) and copper in excess of the ANZECC guidelines.

6.5. Environmental effects on aquatic biota

As summarised in Section 6.4 above, typical stormwater contaminants are sometimes found in the receiving environment (either or both the water column and sediments) at concentrations exceeding environmental guidelines, such as the ANZECC (2000) guidelines for sediment or water quality. This indicates an increased risk of environmental effects, rather than actual effects. In these situations, the ANZECC (2000) guidelines framework provide for either assessment of actual effects or remediation/mitigation.

Apart from this, there is only limited direct information on the actual effects of stormwater discharges, or stormwater-associated contaminants on aquatic biota in the region. A number of reports do provide some very interesting information on the general health of urban streams that have a significant part of their catchment within urban areas (hence derive a significant part of their flow from urban stormwater), as summarised below.

6.5.1. Freshwater

There does not appear to be any studies that directly assess the effects of stormwater discharges on freshwater biota. It is noted however that the bundle of consents granted to Hastings District Council for its stormwater discharges contains requirements for biological monitoring, thus a significant amount of information should become available in the near future.

Although not solely centred on the effects of stormwater discharges, the HBRC reports on the state of urban streams within the Napier (Stansfield, 2009a) and Hastings District (Stansfield, 2009b) urban areas do shed some light on some relevant patterns. In particular, it was found that urban streams within both urban areas present poor to very poor biological communities. Streams with a catchment dominated by urban landuse had poorer communities than streams with a more rural catchment. It was also found that that the percentage of impervious landcover in the catchment was a key driver of the poor state of communities. However, one has to bear in mind that other factors than stormwater discharges, but also driven by urban landuse (including highly modified in-stream habitat, lack of riparian vegetation, highly modified hydrology) also probably contribute to the poor state of the communities in urban streams.

6.5.2. Estuaries and harbours

The largest proportion of data available directly in relation to stormwater discharges to harbours and estuaries concerns physical and chemical determinands, such as contaminant concentrations in the environment, and the associated assessment of effects is generally limited to an assessment of risk of effects obtained by comparing observed concentrations with environmental guidelines.

Studies that do include biological components have generally concluded that the composition of macroinvertebrate communities seem to be primarily driven by sediment composition, in particular the proportion of fine sediments (Madarasz-Smith, 2007 and 2008; Smith, 2010), and no direct association between contaminant concentrations and fauna composition have been identified. It is noted however that

stormwater discharges can carry significant amounts of fine sediment, which in turn can influence the benthic habitat composition.

Smith (2010) notes the presence or dense patches of macroalgae, as well as elevated nutrient concentrations in the sediments near the Purimu/GPC drain discharge points to the Ahuriri Estuary, although not direct conclusions are drawn on the effects of stormwater discharges on the nutrient status of the receiving environment.

7. Conclusions

7.1. Summary of findings

Stormwater discharges from urban areas and industrial and trade premises in the Hawke's Bay Region are either permitted, controlled, or discretionary activities under the RRMP and proposed Coastal Plan. The Hawke's Bay Regional Council administers 107 individual resource consents for controlled stormwater discharges, including 74 for discharges from individual trade or industrial premises, and 33 from urban areas. Most (but not all) urban stormwater catchments in the Napier City and Hastings District are subject to existing resource consents, and resource consent applications and pre-applications are being progressed for the Central Hawke's Bay and Wairoa District main urban centres. The Hawke's Bay Regional Council has also engaged in a process aiming at identifying the remaining trade or industrial premises that would require resource consent for their stormwater discharges.

Stormwater is generally discharged near the catchment where it is generated, so by definition, the greatest concentration of stormwater discharges from urban and industrial discharges occur near the main urban and industrial centres. Of the main freshwater and estuarine systems, the Ahuriri Estuary is by far the system that has the greatest proportion (13%) of its surface catchment occupied by built-up areas. The Clive/Karamu river catchment is the only other main surface water system where built-up areas occupy a more than minor proportion of its catchment (4.2%).

Stormwater-associated contaminants are typically metals/metalloids, hydrocarbons, sediment, bacteria, and nutrients. A number of studies undertaken either in relation to specific resource consent processes, or as part of wider projects provide valuable information on the presence and levels of these contaminants in the stormwater systems and in the receiving environments.

The background levels, i.e. the levels of contaminants in the context of the current general rural land use but in the absence of direct influence of urban or industrial stormwater discharges, are relatively well characterised for the different types of aquatic environment in the region and are supported by background levels obtained in other regions of New Zealand. These provide very valuable benchmark values, enabling the early detection of contamination (i.e. well before it breaches environmental guidelines). The present report provides a compilation of such information (Table 4).

The contaminant levels in stormwater discharges and in stormwater collection network is also relatively well characterised. Typically, most metals and metalloids tested for are detected, but only copper, lead, and, most predominantly, zinc are generally present at elevated concentrations. Polycyclic Aromatic Hydrocarbons (PAHs) are often detected when analysed, sometimes at concentrations exceeding environmental guidelines. Lastly, nutrient concentrations, in particular DRP, appear to be a feature of many urban stormwater discharges.

Based on monitoring information available regionally, it appears that significant metal contamination can be found in predominantly residential catchments, sometimes at levels similar to those found in industrial catchments (Strong 2005b). This seems to be at odds with the operative and proposed regional planning framework, which distinguishes between stormwater discharges from residential (permitted) and industrial/trade (controlled) areas. Given the potential implications of such finding, it is suggested that this point be examined further.

In freshwater receiving environments, there appears to be very limited direct information to support an assessment of effects of stormwater discharges on aquatic life. However, studies with a wider scope have shown that urban streams generally have poor to very poor aquatic communities, much poorer than comparable streams with a predominantly rural catchment (Stansfield, 2009a) The degree of imperviousness in the catchment (a measure of urbanisation) was found to be a key driver (Stansfield, 2009b).

Estuaries represent the downstream receiving environments of the freshwater drainage network and are sensitive to the same effects of land-use activities as streams and rivers throughout the catchment. In New Zealand, estuaries are being recognised as the coastal environments most at risk, as they are the depositional end-point for the accumulative contaminants from the surrounding catchment (Madarasz-Smith, 2007). The monitoring information available in estuaries often shows that the influence of stormwater discharges on contaminant concentrations is generally measurable, and can be widespread at a whole system scale. For example, metal concentrations in the wider Ahuriri Estuary sediment appear to be more elevated than the regional background levels.

Contaminant concentrations in excess of environmental guidelines have been identified at sites located in close proximity to stormwater outlets in the Ahuriri Estuary and the Napier Harbour (Iron Pot). In situations where the trigger values are exceeded, the ANZECC (2000) guidelines recommend that either the actual effects on aquatic biota be assessed or remediation action be undertaken. However, such exceedances of environmental guidelines appear to be generally confined to areas directly affected by significant point-source stormwater discharges, thus the risk of actual effects on aquatic biota, signalled by guideline exceedances is likely to be localised. Contaminant concentrations at sites distant from stormwater outlets generally remain below environmental guidelines, with the notable exception of the Iron Pot, where monitoring has indicated extensive petroleum hydrocarbon contamination by petroleum hydrocarbons (heavy fuels).

7.2. Information gaps

As identified previously in this report, there is currently little specific information on the characteristics or effects of the stormwater discharges from the region’s largest urban and industrial areas (i.e. Hastings District urban areas). This is a significant gap given that stormwater from these catchments is collected by a network of small, low gradient streams, which converge to a tidal estuary. The bundle of consents recently granted to Hastings District Council requires some monitoring, which will in effect address parts of this information gap. However, the resource consent conditions do not appear to contain specific provisions relating to the monitoring of stormwater-related contaminants in the lower Clive River and/or the Waitangi Estuary.

Temporal patterns, in particular temporal trends in relation to stormwater contaminant levels in both stormwater discharges and receiving environment (i.e. are contaminant levels getting better or worse?) do not appear to have been studied in the Hawke’s Bay Region, probably due to a lack of consistent time series.

Although it was largely outside the scope of this report, very little information specific to the Hawke’s Bay Region could be found on the characteristics or effects of stormwater from the roading network. One report, prepared in support of the resource consent application for the Napier airport stormwater discharges, identifies that the stormwater from the adjacent highway may contribute as much contaminants to the South-eastern wetland as the airport area (MWH, 2010b). One of the discharges (from the roading network) is permitted under the operative planning framework; the other (airport, a trade/industrial premise) is controlled. It is suggested that the potential for stormwater discharges from roads and highways outside the urban areas be investigated, particularly in relation to the vulnerability of the different types of receiving environment, to support the development of the future policy framework. Work undertaken in other regions in New Zealand could be used as a basis for this investigation.

There does not appear to be any information relative to the assessment of the potential effects of stormwater discharges to unconfined aquifer. Most resource consents allowing such discharges require no or very limited monitoring.

7.3. Recommendations

As identified above, some monitoring results suggest that stormwater from predominantly residential areas could lead to significant metal contamination of downstream systems, possibly similar to those resulting from predominantly industrial catchments. Given the potential implications of such finding, it is suggested that this point be examined further. In particular, these findings are based on a limited number of results from a single study, and additional monitoring information would be useful to confirm or otherwise, their relevance across the Hawke's Bay Region. It is also suggested that the composition of the urban land use/zoning in the catchment above each monitoring site could be determined and used as a variable in a statistical analysis of monitoring results available region-wide.

Given the demonstrated presence of contaminants in the receiving environments, it is strongly recommended to pursue a regular, long-term monitoring programme to identify temporal trends at the system/catchment level.

The parts of the Waitangi Estuary that are directly influenced by the inputs from the Clive River catchment constitute the final receiving environment for the largest urban and industrial stormwater catchment in the region. There does not appear to be any monitoring information relating to the degree of contamination of this estuary by stormwater-borne contaminants, and this information gap does not appear to be addressed by the consent conditions associated with the stormwater discharges from the Hastings District urban areas. It is recommended that some monitoring, such as sediment quality monitoring, be undertaken in parts of the Waitangi Estuary that are directly influenced by the Clive River inputs. The investigation could initially be targeted to the main contaminants of concern identified elsewhere in the region, i.e. metals (in particular zinc, copper and lead) and PAHs.

Based on the information available, the risk of effects due to stormwater discharges appears to depend on the type or sensitivity of the receiving environment. For example, a small low-gradient stream or a and/or highly depositional part of an estuary are likely to be more at risk from a local accumulation of persistent contaminants brought by stormwater, than, say, a large, fast flowing/gravel bottom river, or a high energy coastal environment, where dilution and dispersion of contaminants are evidently much greater. Recommendations relating to policy matters are outside the scope of this report, but, from a technical perspective, it is recommended that any assessment of effects of stormwater discharges should initially include an appraisal of the sensitivity of the receiving environment as well as the nature of the discharge.

Table 4: Summary of contaminant concentrations measured in the Hawke's Bay Region, in stormwater systems (discharges and drains), and in the environment. Background environment concentrations are reported from systems unexposed to urban or trade/industrial discharges. Environment concentrations are reported for sites located in direct proximity of stormwater discharge outlets (typically at the limit of the zone of reasonable mixing), for sites located within the same receiving environment (e.g. same estuary) but distant from any significant stormwater input. Water column guidelines are 2000 ANZECC trigger values for 95% protection level, with 99% and 90% protection level trigger values reported in brackets. All water concentrations in ppb (µg/L) and sediment concentrations in mg/kg (dry weight). Water metal concentrations are reported as total metal concentrations. Only the most common PAHs are reported. ND: No data.

Contaminant	Medium	Stormwater systems	Environment (Background)	Exposed (close)	Exposed (distant)	Guideline
Suspended solids						
TSS (mg/L)	Freshwater	ND	ND	ND	ND	N/A
	Coastal water	3-410[a] 32[b]	ND	ND	ND	
Metals/metalloids						
Arsenic (As)	Freshwater	1.2[c]	ND	<DL[c]	ND	24 (1-94)
	Coastal water	2-4[b][i] <DL[j]	ND	ND	ND	N/A
	Sediment (freshwater)	3.8 – 6.4[c]	3.0 (1.2-4.2)[f] 2-4[g][h]	3.6[c] 6-27[g][h][k]	ND	20 (ISQG-L) 70 (ISQG-H)
	Sediment (coastal)		3[e] 3.6 (2.3-6.8) [f]	17[b] 4-5[e]	9[b]	
Cadmium (Cd)	Freshwater	0.1 [c] <DL – 0.6[d]	ND	<DL[c]	ND	0.2 (0.06-0.4)
	Coastal water	0.1-1.35[a] 0.11-0.32 [b][i] <DL[j]	ND	ND	ND	5.5 (0.7-14)
	Sediment (freshwater)	0.2 – 0.6[c]	0.06 (<0.05-0.17)[f] 0.03-0.12[G, h]	0.6[c] 0.3-0.7[g,h,k]	ND	1.5 (ISQG-L) 10 (ISQG-H)
	Sediment (coastal)		0.06[e] 0.08 (<0.05-0.18)[f]	0.05-0.5[a] 0.64[b] 0.11-0.18[e]	0.21[b]	
Chromium (Cr)	Freshwater	3.7[c]	ND	<DL[c]	ND	N/A
	Coastal water	<DL[i] - 19[(a)9j)] 2-7.5 [b]	ND	ND	ND	27.4 (7.7-49)
	Sediment (freshwater)	11 – 19[c]	16 (10-23)[f] 15-18[g,h]	14[c] 16-355[g,h,k]	ND	80 (ISQG-L) 370 (ISQG-H)
	Sediment (coastal)	30-63[b]	11[e] 17(14-25)[f]	6.3-18[a] 63[b] 14-18[e]	30[b]	
Copper (Cu)	Freshwater	11.2[c] 0.5-8.3 [d]	ND	<DL-1.6[c]	ND	1.4 (1.0-1.8)
	Coastal water	4 – 33[b][i]	ND	ND	ND	1.3 (0.3-3.0)
	Sediment (freshwater)	13 – 34[c] 9-94[d]	9.4(3.4-25)[f] 7-24[g,h]	24[c] 11-98[g,h,k]	ND	65 (ISQG-L) 270 (ISQG-H)
	Sediment (coastal)	ND	5[e] 10.5 (4.6-19)[f]	2.7-15[a] 83[b] 12-20[e]	40[b]	
Lead (Pb)	Freshwater	8.0[c]	ND	<DL-1[c]	ND	3.4 (1.0-5.6)
	Coastal water	5-17 [b] 1.3-6.0 [i]	ND	ND	ND	4.4 (2.2-6.6)

Contaminant	Medium	Stormwater systems	Environment (Background)	Exposed (close)	Exposed (distant)	Guideline
	Sediment (freshwater)	24-64[c]	7.6 (4.8-13)[f] 7-18[g,h]	39[c] 23-393[g,h,k]	ND	50 (ISQG-L) 220 (ISQG-H)
	Sediment (coastal)	29-105[b]	8 [e] 11 (5.8-27)[f]	105[b] 14-23[e]	29[b]	
Mercury (Hg)	Freshwater	<DL – 0.2[d]	ND	ND	ND	0.6 (0.06-1.9)
	Coastal water	<DL [b]	ND	ND	ND	0.4 (0.1-0.7)
	Sediment (freshwater)	ND	<0.05 [f] 0.05-0.07[g,h]	0.18-0.50[g,h]	ND	21 (ISQG-L) 52 (ISQG-H)
	Sediment (coastal)	ND	<0.05 [f]	4.9-12[a] 0.20[b]	0.13[b]	
Nickel (Ni)	Freshwater	2.3[c]	ND	<DL[c]	ND	11 (8-13)
	Coastal water	0.9-4.2 [b] <DL -1.3 (i)	ND	ND	ND	70 (7-200)
	Sediment (freshwater)	9-21[c]	12 (6.7-17)[f] 8-16[g,h]	7.0[c] 14-23[g,h]	ND	21 (ISQG-L) 52 (ISQG-H)
	Sediment (coastal)	ND	7[e] 13 (8.8-17)[f]	4.9-12[a] 29[b] 9-10[e]	15[b]	
Zinc (Zn)	Freshwater	100[c] 2-133 [d]	ND	<DL-17[c]	ND	8.0 (2.4-15)
	Coastal water	300-600 [b][i]	ND	ND	ND	15 (7-23)
	Sediment (freshwater)	200-310[c] 90-1,210[d]	43 (27-56)[f] 47-125[g,h]	165[c] 148-1210[g,h,k]	ND	200 (ISQG-L) 410 (ISQG-H)
	Sediment (coastal)	ND	50[e] 55 (35-92)[f]	28-75[a] 640[b] 160-320[e]	200[b]	
Organic contaminants						
Total Petroleum Hydrocarbons (TPH)	Freshwater	<DL-1,400[c]	ND	<DL[c]	ND	N/A
	Coastal water		ND	ND	ND	N/A
	Sediment (freshwater)	<DL-410[c]	ND	<DL[c]	ND	N/A
	Sediment (coastal)	ND	ND	< DL[a] 345[b]	240[b]	N/A
PAHs (total)	Freshwater	ND	ND	ND	ND	
	Coastal water	ND	ND	ND	ND	
	Sediment (freshwater)	ND	ND	ND	ND	
	Sediment (coastal)	ND	0.080[l]	1.617[b] 5.9[l]	1.166[b] 0.080-0.120[l]	N/A
Anthracene	Freshwater	<DL[c]	ND	<DL[c]	ND	
	Coastal water		ND	ND	ND	
	Sediment (freshwater)	<DL[c]	ND	<DL[c]	ND	0.085 (ISQG-L) 1.100 (ISQG-H)
	Sediment (coastal)	ND	0.003[l]	0.015[b] 0.140[l]	0.015[b] 0.001-0.005[l]	
Benzo[a]pyrene	Freshwater	<DL[c]	ND	<DL[c]	ND	ND
	Coastal water	ND	ND	ND	ND	ND

Contaminant	Medium	Stormwater systems	Environment (Background)	Exposed (close)	Exposed (distant)	Guideline
	Sediment (freshwater)	<DL-0.250(c)	ND	<DL-0.17(c)	ND	0.430 (ISQG-L) 1.600 (ISQG-H)
	Sediment (coastal)	ND	0.011(l)	0.177(b) 0.680(l)	0.115(b) 0.005-0.018(l)	
Benzo[a]anthracene	Freshwater	<DL(c)	ND	<DL(c)	ND	
	Coastal water		ND	ND	ND	
	Sediment (freshwater)	<DL-0.27(c)	ND	<DL-0.17(c)	ND	0.261 (ISQG-L) 1.600 (ISQG-H)
	Sediment (coastal)	ND	0.009(l)	0.106(a)-0.113(b) 0.901(l)	0.087(b) 0.006-0.032(l)	
Benzo[b] fluoranthene	Freshwater	<DL(c)	ND	<DL(c)	ND	
	Coastal water	ND	ND	ND	ND	
	Sediment (freshwater)	0.05-0.56(c)	ND	0.17-0.29(c)	ND	N/A
	Sediment (coastal)	0.152-0.263(b)	0.014(l)	0.263(b)-0.680(l)	0.152(b) 0.007-0.019(l)	
Chrysene	Freshwater	<DL(c)	ND	<DL(c)	ND	
	Coastal water		ND	ND	ND	
	Sediment (freshwater)	<DL-0.27(c)	ND	<DL-0.17(c)	ND	0.384 (ISQG-L) 2.800 (ISQG-H)
	Sediment (coastal)		0.011(l)	0.117(a)-0.127(b) 0.680(l)	0.086(b) 0.005-0.018(l)	
Dibenzo[a,h] anthracene	Freshwater	<DL(c)	ND	<DL(c)	ND	N/A
	Coastal water		ND	ND	ND	N/A
	Sediment (freshwater)	<DL(c)	ND	<DL(c)	ND	0.063 (ISQG-L) 0.260 (ISQG-H)
	Sediment (coastal)		0.003(l)	0.033(b) 0.330(l)	0.017(b) 0.002-0.012(l)	
Fluoranthene	Freshwater	<DL(c)	ND	<DL(c)	ND	N/A
	Coastal water	0.02 (b)	ND	ND	ND	N/A
	Sediment (freshwater)	0.07-1.10(c)	ND	0.02-0.61(c)	ND	0.600 (ISQG-L) 5.100 (ISQG-H)
	Sediment (coastal)		0.018(l)	0.214(b) 1.149(l)	0.191(b) 0.007-0.022(l)	
Fluorene	Freshwater	<DL(c)	ND	<DL(c)	ND	N/A
	Coastal water	<DL-0.01 (b)	ND		ND	N/A
	Sediment (freshwater)	<DL(c)	ND	<DL(c)	ND	0.019 (ISQG-L) 0.540 (ISQG-H)
	Sediment (coastal)		ND		ND	
Naphtalene	Freshwater	<DL(c)	ND	<DL(c)	ND	16 (2.5-37)
	Coastal water		ND		ND	70 (50-90)
	Sediment (freshwater)	<DL(c)	ND	<DL(c)	ND	0.160 (ISQG-L) 2.100 (ISQG-H)
	Sediment (coastal)		ND	ND	ND	
Phenanthrene	Freshwater	<DL(c)	ND	<DL(c)	ND	N/A
	Coastal water	ND	ND	ND	ND	N/A
	Sediment (freshwater)	<DL-0.30(c)	ND	0.12-0.30(c)	ND	0.240 (ISQG-L) 1.500 (ISQG-H)

Contaminant	Medium	Stormwater systems	Environment (Background)	Exposed (close)	Exposed (distant)	Guideline
	Sediment (coastal)		ND	0.075[b]	0.074[b]	
Pyrene	Freshwater	<DL[c]	ND	<DL[c]	ND	N/A
	Coastal water	0.05-0.08[b]	ND	ND	ND	N/A
	Sediment (freshwater)	0.08-0.98[c]	ND	0.35-0.69[c]	ND	0.665 (ISQG-L) 2.600 (ISQG-H)
	Sediment (coastal)	ND	0.010[l]	0.259[b] 1.332[l]	0.213[b] 0.008-0.028[l]	
Nutrients						
Dissolved Reactive Phosphorus (DRP)	Freshwater	8-240[c] 13-730 [d]	ND	12-110[c]	ND	15
Dissolved Inorganic Nitrogen (DIN)	Freshwater	13-810[c]	ND	22-820[c]	ND	N/A
Total Phosphorus	Sediment (Coastal)	ND	300[e]	400-550[e]	ND	N/A
Total Nitrogen	Sediment (Coastal)	ND	600[e]	1,500-2,500[e]	ND	N/A
Organic Matter (AFDW, as %W/W)	Sediment (Coastal)	ND	1[e]	4[e]	ND	N/A

[a] Port of Napier 2009 – 2010 data.

[b] Burns Road-Ahuriri Catchment discharge to the Iron Pot, from Smith (2007).

[c] Napier airport stormwater discharge to the SouthEastern Wetland (MWH, 2010).

[d] Central Hawke's Bay District Council data, August 2010-Jan 2011. Note: dissolved metal concentrations.

[e] Ahuriri Estuary sediment results (Smith, 2010). Mean concentrations visually estimated from graphs.

[f] Mean background concentration (min-max), based on a region-wide study of lagoon and estuarine sites (Strong, 2005).

[g] Monitoring of trace metal concentrations in the sediment of streams receiving stormwater discharges from three study catchments (rural, residential and industrial) (Strong, 2005)[8].

[h] Strong, 2004

[i] Burns Rd Drain, August 2010 results.

[j] County Drain stormwater sampling results, March 2010.

[k] Monitoring of trace metal concentrations in Purimu and County drains (EAM, 2005)

[l] Analysis of metal and PAHs in sediment and fish and cockle flesh in the Ahuriri and Porangahau Estuary (Ataria *et al.*, 2008).

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[8] For the purpose of this report,, the concentrations measured in the "rural" catchment are considered as "background" concentrations, and the concentrations measured at the "residential" and "industrial" are considered "exposed – close proximity).

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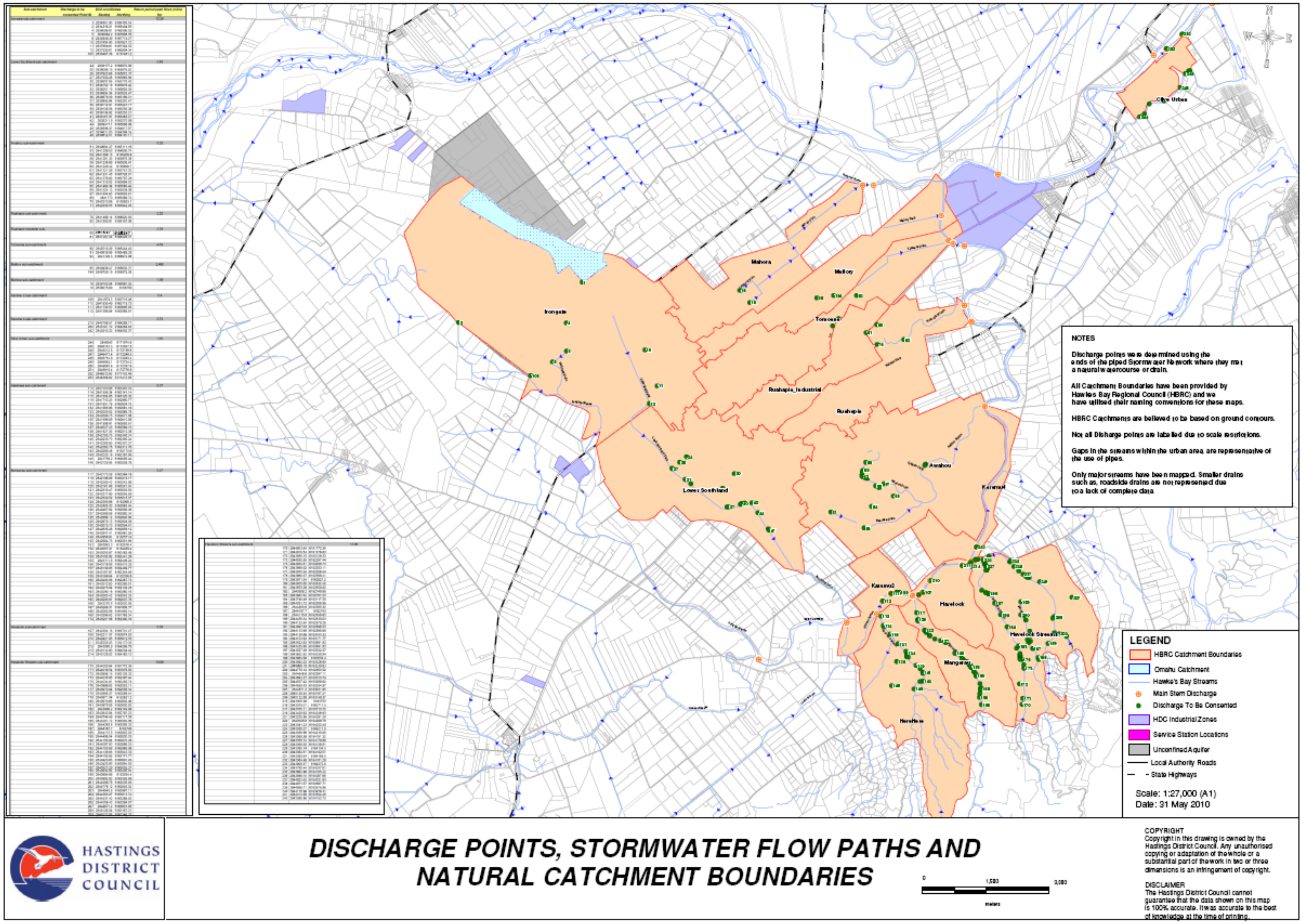
APPENDICES

Appendix A: Map of Hastings District Council stormwater discharges and catchments (not including discharges to unconfined aquifer). (Map Courtesy of Hastings District Council)



Appendix B: Operative consents for the discharge of stormwater from industrial and/or trade premises that require discharge or receiving environment monitoring as part of the conditions of consent. Key: Catch[t]: catchment; Disch.: Discharge; Freq: Frequency; Receiv WQ: Receiving Water Quality; Sed: Sediment; Biom.: Biomonitoring; Req.: Required; Indust.: Industrial; FW: Freshwater; Y: Yes; N: No; N.S: Not specified (in the consent conditions)

Discharge				Receiving Environment			Monitoring						Treatment		
Consent	Name	Class	Catch[t] (ha)	Name	Type	Subtype	Disch.	Freq. (/year)	Receiv. WQ	WQ freq (/year)	Sed	Biom	Req	Treatment Device	Removal
DP990453 W	Heinz Wattie's Limited	Indust.		Ruahapia Stream	FW	River	N		Y	2	N	N			
DP990094 Wa	Pacific Wide (NZ) Limited	Indust.		NCC Drain	FW	Drain	Y	4	N		N	N			
DP982404 W	Genesis Power Limited	Indust.		Lake Whakamarino	FW	Lake	Y	1	N		N	N			
DP090384 W	Cavalier Spinners Limited	Indust.		Awatoto Drain	FW	Drain	Y	1	N			N			
DP080455 L	McCain Foods (NZ) Limited	Indust.		Heretaunga Plains unconfined aquifer	Land	GW	Y	?	N			N			
DP080212 W	Hawke's Bay Woolscourers Ltd	Indust.		Awatoto Drain	FW	Drain	Y	2	N			N			
DP080148 L	Crasborn Group Limited	Indust.		Heretaunga Plains unconfined aquifer	Land	GW	Y	1	N			N			
DP060648 L	Pan Pac Forest Products Limited	Indust.			Land	Land	Y	1	N			N	Y	Multi-chambered traps	
DP060475 L	Works Infrastructure Limited	Indust.	5.11	Heretaunga Plains unconfined aquifer	Land	GW	Y	1	N			N	Y	Humeceptor STC18	

Discharge				Receiving Environment			Monitoring						Treatment		
Consent	Name	Class	Catch^{t} (ha)	Name	Type	Subtype	Disch.	Freq. (/year)	Receiv. WQ	WQ freq (/year)	Sed	Biom	Req	Treatment Device	Removal
DP050426 W	Turners & Growers Limited	Indust.		Karamu Stream	FW	Stream	Y	1	N			N	N		
DP050349 L	Jara Family Trust	Trade		Irongate Stream	FW	Stream	Y	1	N			N	Y	wetland pond	NS
DP050111 L	Omahu 1422 Limited	Indust.		Heretaunga Plains unconfined aquifer	Land	GW	Y	2	N			N	Y	Triple interceptor tank	NS
DP050042 La	Ballance Agri-Nutrients Limited	Indust.		Irongate Stream	FW	Stream	Y	2	N			N	N		
DP050042 La	Ballance Agri-Nutrients Limited	Indust.		Irongate Stream	Land	Land	Y	2	N			N	Y	retention pond	75% TSS
DP050006 w	Silver Fern Farms Limited	Indust.		Karamu Stream	FW	Stream	Y	1	Y	1		N	N		
DP040500 W	Whakatu Coldstores Limited	Indust.	16.3	Clive River	FW	River	Y	1	Y	1		N	NS		
DP040481 W	Apollo Pac Ltd	Indust.		Karamu Stream	FW	Stream	Y	1	Y	1		N	NS		
DP040143 W	Ravensdown Fertiliser Co-operative Limited	Indust.		Tutaekuri (Waitangi) Estuary	Coastal water	Estuary	Y	52	Y	NS	Y	Y	Y	Settlement pond	
DP040121 W	Hastings District Council & Napier City Council	Indust.	NS	Swamp Road Drain	FW	Drain	Y	2	Y	2		N	Y	Stormwater ponds	75% TSS
DP030658 L	Cedenco Foods	Indust.	NS		Land	Land	Y	Once	N			N	Y	Hynds Env. Downstream Defender	

Discharge				Receiving Environment			Monitoring						Treatment		
Consent	Name	Class	Catch[t] (ha)	Name	Type	Subtype	Disch.	Freq. (/year)	Receiv. WQ	WQ freq (/year)	Sed	Biom	Req	Treatment Device	Removal
DP030301 L	Firth Industries & Winstones Aggregates	Indust.	NS		Land	Land	Y	1	N			N	Y	Holding pond	
DP020470 W	Alto Packaging Limited	Indust.	NS	roadside drain	FW	Drain	Y		N			N	NS		
DP020133 L	Walmsley Contracting Limited	Indust.		Te Waikaha Stream	FW	Stream	Y	12 (1st yr)	Y	2	Y	N	Y	Sedimentation pond	
DP010614 W	Shell New Zealand Limited	Indust.	NS	Petane Drain	FW	Drain	Y	1	N			N	Y	API Separator	
DP010456 L	Ballance Agri-Nutrients Limited	Indust.	NS	Unnamed tributary	FW	River	Y	2	N			N	Y	storage pond and land irrigation no treatment for roof water	
DP000168 W	Chevron New Zealand	Indust.	0.024	open drain	FW	Drain	Y	1	N			N	Y	API Separator	
CD990441 W	Chevron New Zealand	Indust.	NS	Iron Pot	Coastal Water	Estuary	Y	1	N			N	Y	API Separator	
CD080276 W	BP Oil New Zealand Ltd	Indust.	NS	Iron Pot	Coastal water	Estuary	Y	Once initially	N			N	Y	Tank NA1 then API separator	
CD040033 Wa	Port of Napier Limited	Indust.	NS	Coastal marine Area	Coastal Water	Open Coast	Y	1	Y	1	Y	N	NS	NS	
DP100217 W	Hawke's Bay Airport Ltd	Indust./ trade	4.9	Southeastern Wetland	Coastal water	Wetland	Y	3	N	0	Y	N	Y	Wetlands	N

Appendix C: Summary of Hastings District Council stormwater discharges, authorised by 15 resource consents granted in May 2010.

<table>
<tr><th>Town</th><th>Catchment</th><th>Primary receiving environment</th><th>N. of outfalls (indicative)</th><th>Downstream receiving environments</th></tr>
<tr><td rowspan="7">Hastings</td><td>Lower Southland</td><td>Southland Drain</td><td>17</td><td rowspan="6">Karamu Stream⇨
Clive River⇨
Clive River Estuary⇨
Ocean</td></tr>
<tr><td>Awahou</td><td>Awahou Stream</td><td>16</td></tr>
<tr><td>Ruahapia</td><td>Ruahapia Stream</td><td>2</td></tr>
<tr><td>Ruahapia Industrial</td><td>Ruahapia Stream</td><td>2</td></tr>
<tr><td>Tomoana</td><td>Tomoana Drain</td><td>3</td></tr>
<tr><td>Mallory</td><td>Mallory Drain</td><td>2</td></tr>
<tr><td>Mahora</td><td>Mahora Drain</td><td>2</td><td>Raupare Stream⇨
Karamu Stream⇨
Clive River⇨
Clive River Estuary⇨
Ocean</td></tr>
<tr><td rowspan="3">Flaxmere</td><td rowspan="3">Irongate</td><td>Wellwood Drain</td><td>4</td><td rowspan="2">Irongate Stream⇨
Karamu Stream⇨
Clive River⇨
Clive River Estuary⇨
Ocean</td></tr>
<tr><td>Irongate Stream</td><td>2</td></tr>
<tr><td>Southland Drain</td><td>3</td><td>Karamu Stream⇨
Clive River⇨
Clive River Estuary⇨
Ocean</td></tr>
<tr><td rowspan="5">Havelock North</td><td>Here Here</td><td>Here Here Stream</td><td>16</td><td rowspan="2">Karamu Stream⇨
Clive River⇨
Clive River Estuary⇨
Ocean</td></tr>
<tr><td>Mangarau</td><td>Mangarau Stream</td><td>>30 (34)</td></tr>
<tr><td>Karamu2</td><td rowspan="2">Karamu Stream</td><td>4</td><td rowspan="2">Clive River⇨
Clive River Estuary⇨
Ocean</td></tr>
<tr><td>Havelock</td><td>7</td></tr>
<tr><td>Havelock Streams</td><td>Te Kahika Stream
School Stream
Karituwhenua Stream</td><td>>50 (57)</td><td>Karituwhenua Stream⇨
Karamu Stream⇨
Clive River⇨
Clive River Estuary⇨
Ocean</td></tr>
<tr><td rowspan="2">Clive</td><td rowspan="2">Clive</td><td>Muddy Creek</td><td>8</td><td rowspan="2">Clive River Estuary⇨
Ocean</td></tr>
<tr><td>Clive River</td><td>2</td></tr>
</table>

Appendix D: Napier City Council. Dry weather flow water quality sampling results, Purimu pumpstation (Consent CD990516W, discharge from the Purimu and GPC drains to the Ahuriri Estuary).

ADWF Sampling - Purimu Pumpstation								
Date	Conductivity	TSS	Sett. Sol	Cu (dissolved)	Cu (total)	Zn (dissolved)	Zn (total)	E. coli
3 November 2003	1176	<5	<5	<0.05	0.2	<0.05	<0.05	10
12 February 2004	4000	40	<1	<0.03	<0.03	<0.05	<0.05	12
28 June 2004	439	<0.1	11	0.027		0.0015		42
22 November 2004	2400	70	<0.1	<0.005	<0.01	<0.01	<0.02	19
8 February 2005	3.8	40	<0.1	<0.01	<0.01	<0.02	<0.02	28
29 June 2005	284	<0.1	8	0.045	0.044	0.003	0.002	130
17 November 2005	344	30	<0.1	<0.01	<0.01	<0.02	<0.02	19
27 February 2006		32	<0.1	<0.01	<0.01	<0.02	<0.02	23
29 June 2006		7	<0.1	<0.003	0.003	0.021	0.039	54
6 November 2006	3690	170	<0.1	<0.05	<0.05	<0.1	<0.1	47
26 February 2007	4000	9	<0.1	<0.01	0.04	<0.02	0.2	26
29 June 2007		33	<0.1	<0.005	<0.005	0.01	0.04	21
16 November 2007	3430	33	<0.1		<0.005		0.024	7
18 February 2008		40	0.1		<0.011		<0.021	380
10 June 2008		34	<0.1	<0.010	0.03			2
4 November 2008	370	7	<0.1	<0.0025	<0.0027	0.029	0.042	38
9 February 2009		62	0.1	<0.010	<0.011	<0.020	0.023	25
12 June 2009		48	0.2	<0.005	<0.011	0.026	0.097	57
9 November 2009	2800	14	<0.1	<0.010	<0.011	<0.020	0.029	100
11 February 2010		50	1.3	<0.0025	<0.00053	0.0066	0.007	150

Appendix E: Napier City Council Monitoring results. Cross County Drain stormwater monitoring. (Data courtesy of EAM Environmental Consultants)

ANALYSIS	UNIT	DETECTION LIMIT	GUIDELINE VALUE	Eriksen Road	The Loop	Ulyatt Road
				9/03/2010	9/03/2010	10/03/2010
				2330	2350	0007
				1035	1034	1036
pH	pH units			7.82	8.02	8.71
Temperature	°C			19.9	22.4	25.4
Conductivity	µS/cm			4950	675	1764
DO	mg/L			8.58#1	0.4#1	15.53#1
DO	% sat					
Faecal coliforms	cfu/100ml			ND	1500	330
HEAVY METALS						
Total Arsenic	g/m^3	0.021	24	< 0.021	< 0.021	< 0.021
Total Cadmium	g/m^3	0.0011	0.2	< 0.0011	< 0.0011	< 0.0011
Total Chromium	g/m^3	0.011	1	0.015	< 0.011	< 0.011
Total Copper	g/m^3	0.011	1.4	< 0.011	< 0.011	< 0.011
Total Lead	g/m^3	0.0021	3.4	0.0055	< 0.0021	< 0.0021
Total Nickel	g/m^3	0.011	11	< 0.011	< 0.011	< 0.011
Total Zinc	g/m^3	0.021	8	0.043	< 0.021	< 0.021
INDIVIDUAL TESTS						
Total Mercury	g/m^3	0.0021	0.6	< 0.0021	< 0.0021	< 0.0021
Total Iron	g/m^3	0.42		7.9	<0.42	<0.42
Total Manganese	g/m^3	0.11	1900	0.72	0.093	0.023
Total Cyanide	g/m^3	0.001	7	< 0.0010	< 0.0010	< 0.0010
Total Ammoniacal-N	g/m3	0.01	900	0.049	0.059	0.1
Nitrite-N	g/m3	0.002		0.0032	<0.0020	<0.0020
Nitrate-N	g/m3	0.002	700	0.0034#2	<0.0020	<0.0020
Nitrite-N + Nitrate-N	g/m3	0.002		0.0028#2	0.0051	<0.0020
Dissolved Reactive Phosphorus	g/m3	0.004		0.25	0.4	0.095
Total Organic Carbon	g/m3	0.5		21	5.9	2.3
Absorbance (G440)	AU 1cm/cell	0.002		0.0112	0.0076	< 0.0020

Appendix F: Napier City Council Monitoring results. Burns Road/Ahuriri catchment, discharge to the Iron Pot, Stormwater monitoring. (Data courtesy of EAM Environmental Consultants).

	SITE	Coronation Street Manhole							
ANALYSIS	UNIT	14/08/2010	14/08/2010	14/08/2010	14/08/2010	14/08/2010	14/08/2010	14/08/2010	15/08/2010
		1700	1800	1900	2000	2100	2200	2300	0000hrs
		1270	1271			1272	1273	1274	1275
pH	pH units	7.97	8.01	8.38	8.33	7.82	8	7.98	8.02
Temperature	°C	12.2	12.3	14.8	15	12.3	12.5	13	12.8
Conductivity	mS/cm	7.35	7.89	47.2	34.5	9.73	10.22	0.128	0.125
Salinity	ppt	3.9	4.2	29.6	21	5.4	5.7	0	0
HEAVY METALS									
Total Arsenic	μ/L-1	2.3	3.7	No analysis due to high salinity result	No analysis due to high salinity result	< 6	< 6	3	2.1
Total Cadmium	μ/L-1	0.088	0.074			< 0.3	< 0.3	0.12	0.095
Total Chromium	μ/L-1	< 0.53	< 0.53			< 3	< 3	< 1.1	< 0.53
Total Copper	μ/L-1	4.8	4.9			9	20	11.8	9.8
Total Lead	μ/L-1	2.2	2.3			1.5	1.3	6	1.81
Total Nickel	μ/L-1	< 0.53	0.55			< 3	< 3	1.3	< 0.53
Total Zinc	μ/L-1	280	290			340	480	590	570

X