Wellington City Stormwater Discharges to the CMA

Resource Consent Applications and assessment of effects on the environment

DECEMBER 2008

capacity

Absolutely Positively Wellington

Me Heke ki Pōneke
Wellington City Council

Prepared by MWH New Zealand Limited
for
Capacity – Wellington Water Management Limited
and
Wellington City Council

December 2008

MWH QUALITY ASSURANCE STATEMENT

MWH PROJECT MANAGER	REVIEWED BY
David Cameron	Jim Bradley
PREPARED BY	**APPROVED FOR ISSUE BY**
David Cameron and Penny Laurenson	David Cameron

WELLINGTON
Level 1, 123 Taranaki Street, Te Aro, PO Box 9624, Wellington 6141, New Zealand
P + 64-4-381 6700, F + 64-4-381 6739

CONTENTS

PART ONE – RESOURCE CONSENT APPLICATION FORMS

The following resource consent is being applied for, to authorise the discharge of stormwater runoff from Wellington City catchments to the coastal marine area and adjacent land:

Coastal permit and discharge permit (sections 12 and 15 Resource Management Act 1991)

The discharge of stormwater collected in infrastructure owned or under the control of Wellington City Council and discharged from culverts and pipes:

- direct to the coastal marine area of Wellington Harbour and the South Coast ; or
- to land adjacent to the coastal marine area of Wellington Harbour and the South Coast

between Horokiwi and Owhiro Bay.

Form 9 of the Resource Management Act 1991

Application for Resource Consent under Section 88 of the Resource Management Act 1991

To: Greater Wellington Regional Council
P O Box 11646
Manners Street
WELLINGTON 6142

We: Wellington City Council
C/- Capacity (Wellington Water Management Limited)
Private Bag 39804
Wellington Mail Centre
PETONE

apply for a coastal and discharge permit for the following discharges:

- To discharge stormwater runoff from urban Wellington City catchments to the coastal marine area of Wellington Harbour and the South Coast.
- To discharge stormwater runoff from urban Wellington City catchments to land adjacent to the coastal marine area of Wellington Harbour and the South Coast, in circumstances which will result in that stormwater entering water and the coastal marine area.

1. **A description of the activities to which the application relates is**:

The discharge of stormwater collected in infrastructure owned or under the control of Wellington City Council and discharged from culverts and pipes:

- direct to the coastal marine area of Wellington Harbour and the South Coast; or
- to land adjacent to the coastal marine area of Wellington Harbour and the South Coast

between Horokiwi and Owhiro Bay.

2. **The name and address of the owner and occupier of the land to which this application relates is:**

Coastal marine area: Crown Land (except for the seabed titles within the Lambton Harbour Development Area as defined in Schedule 2 of the Wellington Harbour and Wellington City Council Vesting and Empowering Act 1987, which are owned by Wellington Waterfront Limited).

Land immediately adjacent to the Coastal marine area: Crown Land or Wellington City Council owned land

3. **The locations of the proposed activities are:**

All stormwater discharges are located on the coastline between Horokiwi and Owhiro Bay under the control of WCC. The stormwater discharges that are the subject of this application fall within 3 categories:

Category 1

The following stormwater discharges, where it is known there are constructed overflows from the wastewater network which result in the occasional discharge of wastewater to the stormwater system:

		NZMG Easting	NZMG Northing
1.	Island Bay Culvert	2,658,231.477	5,983,195.998
2.	Houghton Bay Culvert	2,659,388.515	5,983,457.019
3.	Lyall Bay West Culvert	2,660,107.477	5,984,730.485
4.	Hataitai Culvert (Evans Bay)	2,660,447.955	5,986,727.039

5.	Miramar Culvert (Evans Bay)	2,661,635.762	5,986,472.900
6.	Overseas Passenger Terminal	2,659,594.584	5,989,152.149
7.	Taranaki Street Culvert	2,659,091.911	5,989,231.329
8.	Te Aro Culvert	2,659,056.734	5,989,259.340
9.	Waring Taylor Culvert	2,659,029.965	5,989,022.359
10.	Bowen Street Culvert	2,659,037.130	5,989,114.209
11.	Davis Street Culvert	2,659,780.713	5,991,163.399
12.	Thorndon Quay Culvert	2,659,689.513	5,991,673.137

Category 2

The following stormwater discharges from culverts:

		NZMG Easting	NZMG Northing
1.	Lyall Bay East Culvert	2,660,768.058	5,984,941.778
2.	Kilbirnie Culvert (Evans Bay)	2,660,540.348	5,986,635.085
3.	Cobham Culvert (Evans Bay)	2,660,774.519	5,986,424.409
4.	Tory Street Culvert	2,659,339.390	5,989,290.160
5.	Harris Street Culvert	2,659,041.039	5,989,472.558

Category 3

All other stormwater discharges located on the coastline between Horokiwi (NZMG 2,665,105E; 5996067N) and Owhiro Bay (NZMG 2,656,372E; 5,982,825N) under the control of WCC that may from time to time not meet the conditions of the permitted activity rules in the Regional Coastal Plan or Discharge to Land Plan.

4. No additional resource consents are need for this proposal.

5. Attached, in accordance with the Fourth Schedule of the Resource Management Act 1991, is an assessment of environmental effects in the detail that corresponds with the scale and significance of the effects that the proposed activity may have on the environment.

   Please refer to the information contained in Section 6 of this application.

6. Attached is information required to be included in the application by the relevant regional plans, the Resource Management Act 1991, or any regulations made under the Act.

   Please refer to the information contained in Part Two of this application

…………………………………………….
Signature of applicant or person authorised
to sign on behalf of applicant

……………………………….
Date

Address for Service:

Capacity (Wellington Water Management Limited)
Private Bag 39804, Wellington Mail Centre
PETONE

Attention: Paul Glennie

Telephone No. 04 910 3833
Fax No. 04 910 3801

PART TWO – SUPPORTING INFORMATION

EXECUTIVE SUMMARY

Purpose

This Assessment of Effects on the Environment has been prepared on behalf of Wellington City Council (WCC) to accompany applications to Greater Wellington Regional Council (GWRC) for resource consents for discharges of runoff from Wellington stormwater catchments to the coastal marine area (or to land adjacent to the coastal marine area) from infrastructure owned, or under the control of, WCC.

Wellington City Stormwater

Wellington City has hundreds of stormwater discharges to the coastal marine area between Horokiwi in Wellington Harbour and Owhiro Bay on Wellington's South Coast. The Wellington City stormwater network includes an estimated 650 kilometres of stormwater pipe ranging from 100mm to 3200mm in diameter. Most of these discharges are contaminated from time to time, to varying degrees, by wastewater (low level background pollution or wet weather overflows) and/or by urban runoff.

The stormwater discharges that are the subject of this application fall within 3 categories:

Category 1: Stormwater discharges, at specified locations, where it is known there are constructed overflows from the wastewater network which result in the occasional discharge of wastewater to the stormwater system.

Category 2: Stormwater discharges, at specified locations, which may from time to time not meet the conditions of the permitted activity rules in the Regional Coastal Plan or Discharges to Land Plan.

Category 3: All other stormwater discharges located on the coastline between Horokiwi and Owhiro Bay under the control of WCC that may from time to time not meet the conditions of the permitted activity rules in the Regional Coastal Plan or Discharges to Land Plan.

Consents Sought

WCC seeks the following resource consent for a term of 10 years:

- A discharge and coastal permit to authorise the discharges of stormwater collected from urban areas in infrastructure owned or under the control of Wellington City:
  - (a) To the coastal marine area (CMA) of Wellington Harbour and the South Coast.
  - (b) To land adjacent to the CMA of Wellington Harbour and the South Coast.

In the catchment area there are also three streams (Owhiro, Kaiwharawhara and Ngauranga) which are open channel water courses that receive multiple stormwater inputs. These are not considered to be discharges to the CMA under the RMA. However, these streams flow into the CMA, within the area covered by this consent, and are relevant as part of the receiving environment. Accordingly, these streams are included in WCC's stormwater monitoring programme and proposed conditions of consent, but consent is not sought for them.

The resource consent will replace the 11 existing discharge consents and will authorise other existing discharges which are not currently consented and have not previously been regarded as requiring consent.

Planning Context

Discharges to the CMA are governed by the provisions or requirements of:

- The Resource Management Act 1991 (RMA)
- The New Zealand Coastal Policy Statement (NZCPS)
- The Wellington Regional Policy Statement (RPS)
- The Regional Coastal Plan (RCP) for the Wellington Region and (because in some circumstances the point of discharge is to land adjacent to the coastal marine area) the Discharge to Land Plan (DLP) for the Wellington Region.
- The Marine Reserves Act 1971

These are detailed in section 4 of this AEE

Effects of stormwater discharges to the CMA

The discharges of stormwater to Wellington Harbour and the South Coast have been assessed in terms of their effects on the environment over the proposed 10 year duration of the consent. There are some potential and actual adverse effects but these are minor and mostly occur within the immediate vicinity of the stormwater outfalls.

A 30m radius mixing zone is proposed for stormwater discharges to bathing beaches and the Taputeranga Marine Reserve, and a 50m radius mixing is proposed for all other stormwater discharges. This two tier approach recognises the more efficient physical mixing characteristics of the exposed waters of the South Coast compared with the relatively sheltered waters of the inner harbour. It also recognises the greater values associated with receiving waters in the marine reserve and at bathing beaches compared with, for instance, the operational port area.

The key findings of this assessment are:

- The stormwater discharges are unlikely to cause the *Contact Recreation* or *Shellfish Gathering* water quality criteria in the RCP to be exceeded, but have the potential, from time to time, to affect water quality at bathing beaches, and to temporarily increase the health risks for bathers and those engaged in other contact recreational activities at such times.
- The risks to public health are appropriately mitigated by WCC's ongoing efforts to detect and correct reticulation faults and by the GWRC/WCC bathing beach monitoring programme, which includes a management response to address health risks, and which may from time to time result in the erection of public health warning signs at bathing beaches.
- The discharges are substantially free of oil and grease and the suspended solids content is normally lower than in natural water courses during an equivalent rainfall event (during a sustained rainfall event the Hutt River can have a major impact on the colour and clarity of Wellington Harbour whereas runoff from urban Wellington is unlikely to have more than a minor effect).
- Stormwater discharges have increased contaminant concentrations in marine sediments around stormwater outlets and to a lesser extent at more distant locations in Wellington Harbour.
- Stormwater discharges have also disturbed marine benthic biota communities within a radius of up to 35 metres from stormwater outlets, but there is no evidence of adverse effects on biological communities beyond the immediately vicinity of outfalls.
- Further monitoring is required to determine if contaminant concentrations in marine sediments are likely to increase, or whether adverse effects on biological communities are likely to occur in the future, beyond a reasonable mixing zone, from these continued discharges of stormwater. For this

reason WCC has sought a consent of 10-year duration, and has proposed a significantly enhanced stormwater quality, marine sediment and benthic ecology monitoring programme to be undertaken over that period.

- The cultural concerns of tangata whenua relate to the effect of the discharge on the mauri of waters of Wellington Harbour and Cook Strait and on the paua, finfish and rock lobster fisheries in the area.

Suggested Conditions

Resource consent conditions are proposed by WCC to ensure the effects associated with the discharge of stormwater to the CMA (and land adjacent to the CMA) are appropriately avoided, remedied or mitigated for the proposed 10 year duration that is sought.

Overall Conclusion

This AEE describes WCC's present stormwater collection and disposal system for the urban area of Wellington City. The system is an important part of the infrastructure of Wellington City and contributes significantly to the health, safety and wellbeing of the city's residents and supports it economic development.

The effects of the stormwater discharges have been outlined and evaluated. The available evidence, from monitoring and special studies, indicates that subject to the mitigation measures proposed and the suggested conditions of consent, the stormwater discharges will not have a significant adverse effect on the water quality or the ecology of receiving waters over the proposed 10 year term of consent.

1 Introduction

1.1 Purpose

The purpose of this AEE is to provide a description and assessment of effects on the environment for an application by Wellington City Council (WCC) to Greater Wellington Regional Council (GWRC) for resource consent for discharges of runoff from Wellington City stormwater catchments to the coastal marine area (CMA). It is intended that this single 'global' consent will replace the 11 current stormwater discharge consents (which are due to expire between June 2009 and February 2016) and would authorise other existing stormwater discharges from Wellington City which are not currently consented, and have not previously been regarded as requiring consent.

This AEE has been prepared in accordance with Section 88(6) and the Fourth Schedule of the Resource Management Act, 1991 (RMA). It includes a description of the proposed activities, the statutory framework within which the applications must be assessed, an assessment of the actual and potential effects of the activities on the environment, and the ways in which any adverse effects arising from the activities can be avoided, remedied or mitigated.

1.2 Consent sought

WCC seeks the following resource consent:

- A discharge and coastal permit to authorise the discharges of stormwater collected from urban areas in infrastructure owned or under the control of Wellington City:
    - (a) To the coastal marine area (CMA) of Wellington Harbour and the South Coast.
    - (b) To land adjacent to the CMA of Wellington Harbour and the South Coast.

In the catchment area there are also three streams (Owhiro, Kaiwharawhara and Ngauranga) which are open channel water courses that receive multiple stormwater inputs. They are not discharges to the CMA under the RMA. However, these streams flow into the CMA, within the area covered by this consent, and are relevant as part of the receiving environment. Accordingly, these streams are included in WCC's stormwater monitoring programme and proposed conditions of consent, but consent is not sought for them.

1.3 Reasons for application

The consent is required to enable the continued lawful discharge of stormwater runoff from Wellington City to the CMA and adjacent land. The consent sought would effectively replace the existing consents (attached in Appendix 1), and would authorise other existing stormwater discharges from Wellington City which are not currently consented. WCC does not seek to authorise through this application any discharges other than those currently established and occurring. (While some expansion of existing stormwater networks is expected in the future WCC does not anticipate the need to establish any new stormwater discharges in the foreseeable future).

1.4 Proposed term of consent

The consent is sought for a period of 10 years. WCC consider that this is an appropriate term due to the limited availability of information in respect of the "non faecal" contaminants in stormwater run-off from Wellington City.

The information gained through additional monitoring of the quality of stormwater, marine sediments and benthic biota near stormwater outlets, proposed by WCC over the next 10-years, will allow a greater appreciation of issues surrounding the discharge of stormwater from Wellington City. In that period it is anticipated that the results of WCC monitoring will be complemented by two further rounds of the GWRC "Wellington Harbour marine sediment quality investigation" (the next round is proposed for 2011, followed by another in 2016 or 2017).

Output from these studies over the next 10 years will enable an analysis of increasing or decreasing trends of contaminant concentrations in marine sediments, and will provide for a more robust assessment of effects on aquatic life.

1.5 Information sources

The main sources of information used during the preparation of this report were:

- Capacity/Wellington City Council stormwater monitoring data (indicator bacteria, heavy metals) and bathing beach monitoring data (indicator bacteria).
- Greater Wellington Regional Council (2008): Wellington Harbour marine sediment quality investigation.
- Greater Wellington Regional Council (2008a) Annual recreational water quality monitoring report.
- Kingett Mitchell Ltd (2005): Assessment of urban stormwater quality in the Greater Wellington Region. Report prepared for Greater Wellington Regional Council.
- MWH NZ Ltd (2008): Monitoring of stormwater discharges from Wellington City to Wellington Harbour and the South Coast.

Other documents referred to in the text are listed in the References section at the end of this AEE

1.6 Scope and layout

This AEE is divided into 10 sections as follows:

Section 1: Introduction
Section 2: Description of WCC Stormwater System
Section 3: Discharge of Stormwater to Coastal Water
Section 4: Planning Context
Section 5: Assessment of Effects of Discharge of Stormwater to Coastal Water
Section 6: Proposed Monitoring Programme
Section 7: Consultation
Section 8: Conclusions and Suggested Consent Conditions

1.7 Abbreviations used

Abbreviations used in this report include:

AEE	=	Assessment of Environmental Effects
ANZECC	=	Australian and New Zealand Environment and Conservation Council
ARI	=	Average recurrence interval
BOD_5	=	Five Day Biochemical Oxygen Demand
COD	=	Chemical Oxygen Demand
CMA	=	Coastal Marine Area
DOC	=	Department of Conservation
DO	=	Dissolved Oxygen
EDC	=	Endocrine Disruption Chemical
FC	=	Faecal coliform
GWRC	=	Greater Wellington Regional Council

I&I	=	Inflow and Infiltration
IS	=	Interceptor sewer
L/s	=	Litres per second
MFE	=	Ministry for the Environment
mg/L	=	Milligrams per litre
µg/L	=	Micrograms per litre
ng/L	=	Nanograms per litre
m^3/day	=	Cubic metres per day
NZCPS	=	New Zealand Coastal Policy Statement
PAHs	=	Poly-cyclic Aromatic Hydrocarbons
PCBs	=	Poly-Chlorinated Bi-phenyls
PWWF	=	Peak Wet Weather Flow
RCP	=	Regional Coastal Plan
RMA	=	Resource Management Act 1991
RPS	=	Regional Policy Statement
SVOC	=	Semi-volatile Organic Compound
SPE	=	Sewage Pollution Elimination
TKN	=	Total Kjeldahl Nitrogen
TP	=	Total Phosphorus
TSS	=	Total Suspended Solids
VOC	=	Volatile Organic Compound
WCC	=	Wellington City Council

2 Wellington City's stormwater system

2.1 Stormwater system overview

Wellington City has literally hundreds of stormwater discharges to the coastal marine area between Horokiwi in Wellington Harbour and Owhiro Bay on Wellington's South Coast. The stormwater catchments are shown in Figure 2.1. The stormwater network includes an estimated 650 kilometres of stormwater pipe ranging from 100mm to 3200mm in diameter.

In many cases the natural water courses have been entirely replaced by a piped stormwater system whereas in other catchments the main stem of the natural stream remains but flow is supplied to the stream by a stormwater network. Most of these discharges are contaminated from time to time, to varying degrees, by wastewater (low level background pollution or wet weather overflows) and/or by urban runoff.

2.2 Stormwater catchments and flows

The most significant of Wellington's stormwater discharges in terms of catchment areas and flow rates are listed below in Table 2.1 (refer to Appendix II for aerial photographs of the major outfalls). The list includes Owhiro, Kaiwharawhara and Ngauranga Streams which are open channel water courses that receive multiple stormwater inputs. Stream discharges to the CMA can have large flows and potentially a significant impact on receiving waters, hence are included in WCC's stormwater monitoring programme. (but WCC is not seeking consent for the stream discharges to the CMA).

Table 2.1: Wellington City's major stormwater discharges

	Stormwater Discharge	Site Code	Catchment Area (ha)	Stormwater discharge flow rate (m^3/s)		Constructed overflow in catchment	Consent Number:	Date of Consent Expiry
				2-year ARI	20-year ARI			
1	Owhiro Stream***	B22017	954	20.1	32	Yes	920066	June 2003*
2	Island Bay Culvert	C26070	501	14.4	23	Yes	920065	June 2009
3	Houghton Bay Culvert	C31040	104	3.2	5.3	Yes	010080	Feb 2016**
4	Lyall Bay West Culvert	F34014	98	5.6	9.3	Yes	920068	June 2010
5	Lyall Bay East Culvert	G37050	42	2.9	4.2	No	NC	--
6	Hataitai Culvert (Evans Bay)	K35037	126	5.2	8.5	Yes	920071	June 2010
7	Miramar Culvert (Evans Bay)	J40010	394	12.8	20.3	Yes	NC	--
8	Kilbirnie Culvert (Evans Bay	--	55	2.7	4.4	No	NC	--
9	Cobham Culvert (Evans Bay)	J37001	69	3.1	5.0	No	NC	--
10	Overseas Passenger Terminal	Q32035	448	15.5	24.5	Yes	920076	June 2013
11	Tory Street Culvert	Q30026	44	2.9	4.6	No	080245	June 2013
12	Taranaki Street Culvert	Q30017	69	3.7	6.0	Yes	920072	June 2009
13	Te Aro Culvert at Jervois Quay	Q29110	235	8.1	13	Yes	NC	--
14	Harris Street Culvert	R29028	18	1.4	2.3	No	NC	--
15	Waring Taylor Culvert	S29079	50	2.5	4.1	Yes	920075	June 2011
16	Bowen Street Culvert	S29091	62	4.2	6.9	Yes	NC	--
17	Davis St Culvert	V32022	187	6.0	9.5	Yes	920074	June 2013
18	Thorndon Quay Culvert	W31010	99	3.2	5.2	Yes	920073	June 2013
19	Kaiwharawhara Stream***	Y33052	1770	29.9	46.9	Yes	NC	--
20	Ngauranga Stream***	AC41016	840	23.7	37.5	Yes	920069	June 2013

* Allowed to elapse
** Renewed on 27 February 2001
*** See para 1.2 above
ARI = Annual Recurrence Interval
NC = Not consented

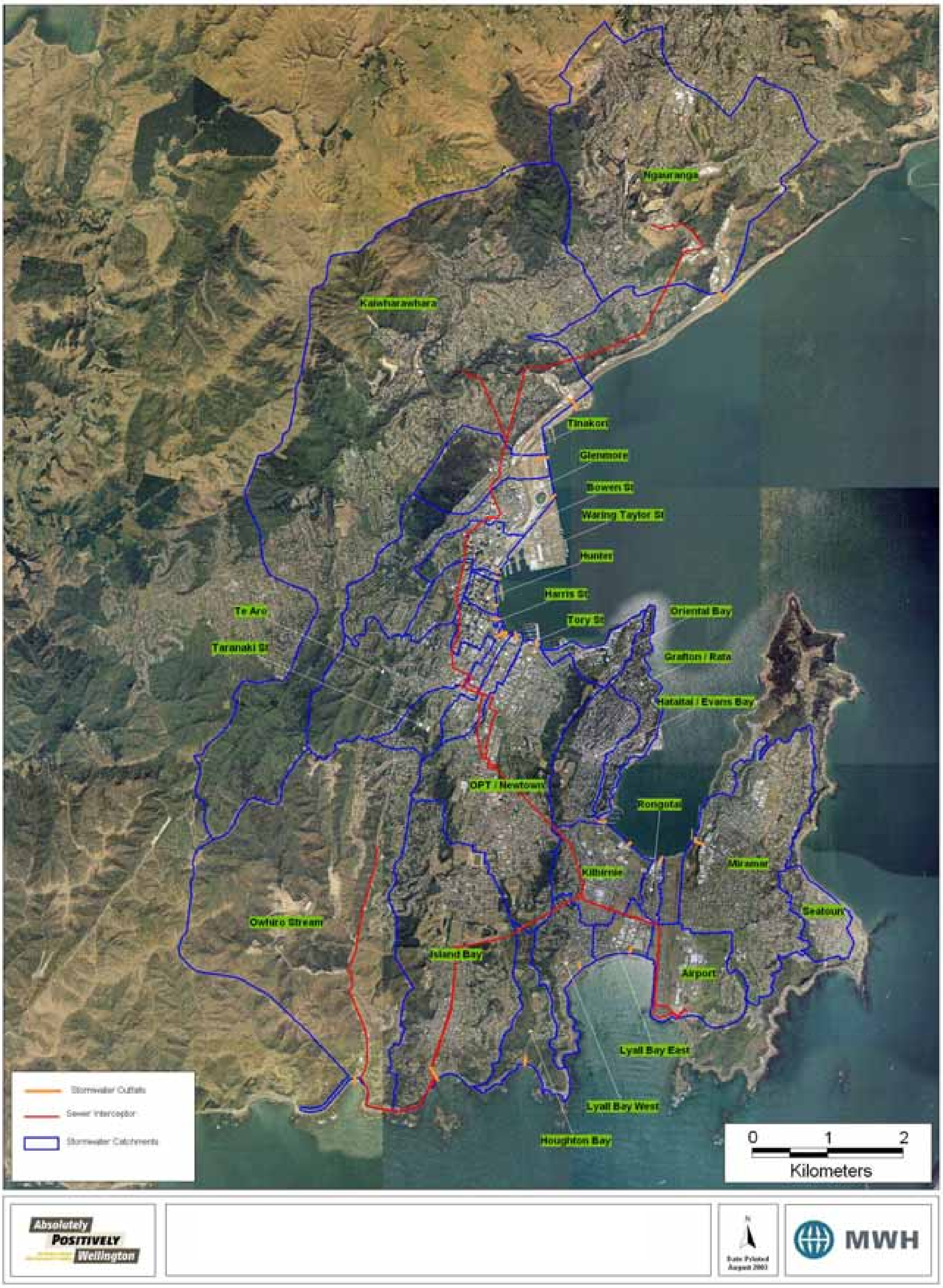

Figure 2.1: Wellington City stormwater catchments

Stormwater runoff rates are determined by the catchment size, slope and shape, the proportion of impervious surfaces in the catchment, storage within the catchment, and the intensity and duration of rainfall within the catchment. Table 2.1 shows the estimated 2 year and 20 year average recurrence interval (ARI) stormwater flows. The catchments listed cover a total area of 5,433 hectares and total runoff from this area would give an estimated combined 2 year ARI stormwater flow rate of 171 m^3/s, or more than 615,000 m^3 per hour.

2.3 Maintenance of the stormwater network

Wellington's stormwater collection system includes 530 stormwater intakes, where natural water courses enter the stormwater system, which are inspected and cleared at various frequencies throughout the year. Approximately 1000m^3 of silt and gravel is removed annually from stormwater intakes for disposal at the Southern Landfill.

The stormwater system also includes 10 stormwater pits (refer Table 3.3) from which 250m^3 of silt and gravel is cleared annually. (In addition, large silt traps are located in Ngauranga and Kaiwharawhara Streams from which approximately 1000m^3 of silt and gravel is cleared annually.)

Significant culverts throughout the City are inspected and cleared of silt and gravel annually. Twenty eight stormwater outlets on the South Coast, which are susceptible to blockage from coastal gravel and sands, are inspected and cleared six times each year.

Wellington City is divided into the CBD and 8 other geographical areas for street cleaning. Each area has designated resources responsible for keeping carriageways, footpaths channels and access-ways clean and tidy and free of detritus that might otherwise enter the stormwater network. Crews and contractors are assigned areas and are made responsible for enquires or complaints and for co-ordinating scheduled work. WCC has three sump cleaning trucks and four mechanical sweepers, as well as smaller gear specific to the CBD. The annual operating budget for street cleaning activities is currently around $6m per annum.

The stormwater collection system includes 12,865 street sumps located underneath the entrance grill to the stormwater pipe. Street sumps are designed to collect heavier material which falls to the bottom of the sump, and to trap floatable material near the top of the sump. Street sumps are emptied on a routine basis (Transit, CBD and "critical sumps" at least 3 times each year, and suburban street sumps 1 or 2 times each year). Routine sump cleaning accounts for an estimated 1500 tonnes of material each year which is cleared and disposed to the Southern Landfill.

Street sweeping accounts for an additional 1350 tonnes of material each year, disposed to the Southern Landfill.

2.4 Elimination of sewage pollution

Wellington City has separate sewerage and stormwater drainage systems. However, stormwater can gain access to the wastewater system by way of direct *inflows* (surface water running into manholes or gully traps, or via illegal cross-connections between the stormwater and wastewater systems), or by way of *infiltration* (groundwater seeping into the sewer via imperfections or cracks in the pipes and fittings). Conversely, wastewater can enter the stormwater system by way of leakage from broken pipes, sewers illegally connected to stormwater drains or wet weather overflows from sewers.

Wellington City Council has a co-ordinated approach to the elimination of wastewater pollution and maintenance of the wastewater network. Co-ordination is achieved by way of the provision of three main documents, all prepared in 1993:

- *Sewage Strategy for Wellington* (Overall objectives, prioritisation of works, risk management issues),
- *Sewage Pollution Elimination Project* (a 15 year programme of works aimed at implementing the Sewerage Strategy),
- *Drainage Rehabilitation Strategy* (a 15 year programme of works aimed primarily at maintenance of the sewer and stormwater network.

<u>Sewage pollution elimination poject</u>

In May 1993, Wellington City Council approved the Sewage Pollution Elimination (SPE) Project, essentially a fifteen year (1993-2008) programme of works aimed at implementing the Sewage Strategy.

In February 1994, Wellington City Council was granted 12 consents for the discharge of wastewater contaminated stormwater to coastal waters. All of the consents contain conditions requiring certain works to be undertaken in accordance with specified timetables with the objective of reducing the frequency and magnitude of wastewater contamination of the stormwater system, e.g:

- Cross connection detection and repair
- Fixing known sewer faults
- Water quality monitoring
- Pump station control and monitoring equipment upgrades
- Pump station overflow prevention
- Intercepting sewer upgrades

The conditions on the stormwater consents reflect both the priorities established in the Sewerage Strategy and the outline works programme contained in the earlier adopted SPE Project (above).[1] Following granting of the consents, the SPE Project was adjusted to incorporate the details of the works and completion dates specified in the consent conditions.

The early focus of the SPE Project was on identifying and repairing leaks in sewer pipes and identifying and eliminating cross-connection faults in priority catchments. Other work has included the upsizing of under-capacity pipes and mains (e.g. triplication of the Kilbirnie Interceptor in 1999), pump station overflow prevention and the sealing off of constructed overflows between the wastewater and stormwater networks.

Expenditure on the SPE Project over the period 1994 to 2007 totalled $58 million (averaging out at $4.1 million per year).

---

[1] At the time that the Strategy and the SPE Project were adopted in 1993, the stormwater consent applications had been lodged but not heard. The consent conditions proposed by WCC reflected the contents of the Strategy and the SPE Project.

Wellington City Council monitoring shows that implementation of the SPE Project has had a marked beneficial effect on the micro-biological quality of stormwater discharges to the Harbour and South Coast. The nature of these improvements is summarised in section 3.3.2 of this document.

Drainage rehabilitation strategy

In June 1993, Wellington City Council approved a Drainage Rehabilitation Strategy (DRS). The maintenance-orientated DRS, which is complementary to the SPE Project, identifies drains that are defined as “critical” i.e. those where the consequence of failure of the drains for public safety, cost and social disruption justify programmed inspections and preventative rehabilitation (repair or renewal).

The DRS was, like the SPE Project, set up as a component of a 15 year programme of works. Annual expenditure of $4.4 million was initially provided for on the basis of an assumed 125 year economic life of a drain and a consequent need to renew 0.8% of drains each year in order to maintain the existing level of service. The level of service was later increased by WCC adopting a strategy to renew 1% of drains each year (at a cost of $8.17 million for the 2007/08 year).

Remaining wastewater pollution issues

Although major advances have been achieved, some problem areas remain. The wastewater system includes 79 constructed overflows (including pump station overflows) to the stormwater system. A wastewater network model, developed by consultants GHD for WCC, was used to assess the frequency and magnitude of overflows from the main interceptor sewer during wet weather (GHD 2007). That investigation indicates that a significant wet weather overflow of wastewater occurs from the interceptor at Murphy Street to the Davis Street stormwater drain which discharges at Aotea Quay in sustained wet weather. This overflow operates approximately 3 to 4 times per year on average. The discharge volume for a 2 year average recurrence interval (ARI) event is estimated at 37,000 m^3.

Constructed overflows on the local sewer network also operate from time to time. In July 2008 WCC installed monitoring equipment at 14 constructed overflow manholes. From July 2008 to 8 December 2008 overflows had occurred at 3 of these manholes. These are:

Manhole ref.	***Location***	***Date of overflow(s)***	***Cause***	***Action Taken***
J42-059	40 Park Road Miramar	3 August 2008	Rain event – stormwater inflow or infiltration	Further monitoring planned to isolate the source of I/I
AD35-026	17a Delhi Crescent, Khandallah	22 October 2008 11 September 2008 8 August 2008 3 August 2008	Rain events – stormwater inflow or infiltration	Cross connection survey undertaken on 386 properties. CCTV inspection underway on sewer main
Q10-005	62 South Karori Road, Karori.	6 September 2008	Rain event – stormwater inflow or infiltration	Under investigation

From July 2009 WCC propose to monitor another 14 overflow manholes over a 12 month period.

2.5 Other contaminants in urban stormwater

The primary focus of the consents granted in 1994 was to reduce the public health risks associated with stormwater discharges and hence reduce their micro-biological content. More recently the potential ecological impacts of sediments, metals and persistent organic compounds in urban stormwater have come under increasing scrutiny and it is evident that a better understanding of the broader environmental effects of stormwater discharges on the marine ecology is required. This is discussed in sections 3.4 and 5.4.

Potentially toxic compounds in stormwater can arise from a number of sources including vehicle exhausts and lubricants (hydrocarbons including PAHs) wear of vehicle tyres and brake pads (zinc, copper, lead) bitumen and other road surfaces (zinc, copper, PAHs), roofs of buildings (zinc), runoff from industrial premises (various), and illegal discharges into the stormwater system (disposal of waste paint, oil etc).

Heavy metals and other contaminants can be transported as either dissolved species or by being chemically bound to sediment particles (particulate contaminants). The literature indicates that a high proportion of the total contaminant load in stormwater is typically associated with the particulate fraction. The New Zealand data (e.g. Timperley 2003) indicates that zinc is the most soluble (up to 40% of the total metal is in the soluble phase) of the key elements in stormwater. Copper appears to be moderately soluble (about 30%) and lead is least soluble (<10%). A high proportion of the total concentration of low molecular weight PAH is present in the dissolved phase, whereas the high molecular weight PAH is predominantly present in the particulate phase (Kennedy 2003).

While a high proportion of the more soluble contaminants such as zinc may be present in the dissolved form ‘at source’, during passage through the drainage network, the dissolved fraction decreases as contaminants absorb to particles (Timperley 2003).

3 Discharge of stormwater to coastal water

3.1 Introduction

To be considered acceptable a discharge must achieve specified receiving water criteria after reasonable mixing (refer sections 4.3 for relevant rules and policies in the RCP). The ability of discharges to achieve the receiving water criteria depends on the composition of stormwater (contaminant content and concentrations) and rates of dilution and dispersion or sediment deposition in the area around the outfall. It may also depend on the size of any nominated mixing zone inside the boundaries of which the criteria do not have to be achieved.

3.2 Reasonable mixing

Wellington City stormwater is discharged to a variety of receiving environments ranging from the sheltered embayments of Evans Bay and Lambton Harbour to the exposed southern coastline which includes the newly established Taputeranga Marine Reserve (from west side of Te Raekaihau to midway between Owhiro bay and Sinclair Head). The discharges vary both in quality and quantity depending on the catchment size and its characteristics, the magnitude and intensity of the rainfall event, as well and wind and tidal conditions. As a consequence the dilution and dispersion (or mixing) characteristics of stormwater discharges are highly variable, both between outfall locations and, for any given location, between discharge events.

The RMA requires that any standards imposed through classification of waters or under section 107 of the RMA should be met “after reasonable mixing”. This implies the existence of a zone in which the underlying standards need not be met. It may be inferred that the area required for “reasonable mixing” should be minimised and that any effects within that zone should not frustrate the management objectives for the surrounding waters.

WCC consider that a “one size fits all” mixing zone is not appropriate in this instance, and propose that “reasonable mixing” would occur:

- within a 30m radius of the discharge point for all discharges to the Taputeranga Marine Reserve or to recognised bathing beaches, and
- within a 50m radius of the discharge point for all other stormwater discharges to the CMA under WCC control.

Such an approach recognises the more efficient physical mixing characteristics of the exposed waters of the South Coast compared with the relatively sheltered waters of the inner harbour. It also recognises the greater values associated with receiving waters in the marine reserve and at bathing beaches compared with, for instance, the operational port area.

3.3 Quality of Wellington stormwater discharges

3.3.1 WCC’s routine stormwater monitoring programme

Since the inception of the SPE project in 1993, Wellington City Council staff have undertaken baseline monitoring of stormwater discharges and receiving waters at 83 sites. The programme includes 28 stormwater sites (in-pipe), 22 urban stream sites (open channel) and 33 near shore marine sites in Wellington Harbour and on the South Coast. All 83 sites are sampled on the same day between the hours of 6 and 11 am, at fortnightly intervals.

Samples from streams and stormwater drains are tested for faecal coliforms and *E. coli*, while sea water samples are tested for faecal coliforms and *enterococci* .[2] Samples from the 11 consented stormwater discharges are tested for all three indicator organisms.

For five of the consented discharges WCC is required to monitor trace metals and other constituents in stormwater twice yearly, with one sample each year being taken during a significant rainfall event.

The indicator bacteria monitoring programme has a strong operational focus, enabling the identification of wastewater reticulation faults as they develop so that remediation work can be directed to the areas where it is needed most. This programme is not specifically directed at wet weather events but is undertaken on a predetermined schedule and is random with respect to weather and tidal conditions. Over time this has allowed almost the full range of conditions to be sampled[3]. A review of the monitoring results is provided in MWH (2008) and a summary is given in the following sections.

3.3.2 Microbiological content of stormwater

Faecal coliform results from fortnightly samples collected at major stormwater discharge sites throughout the network (and some urban streams) are summarised in Table 3.1. The annual median and 95 percentile faecal coliform values for the years to June 1993 and 2008 highlight the improvements achieved by the SPE project over that 15 year period. In many cases a 2-log reduction in indicator bacteria median values has been achieved, and all stormwater discharges show some improvement.

Table 3.1: Stormwater discharge annual median and 95-percentile faecal coliform values (cfu/100ml) for the years to June 1993 and 2008 (26 fortnightly samples per year). Significantly elevated values are shown in red. (* refer section 1.2)

	Stormwater Discharge	Site Code	median		95-percentile	
			1993	2008	1993	2008
1	Owhiro Stream*	B22017	1,200	420	9,400	1,775
2	Island Bay Culvert	C26070	19,000	565	186,000	2,050
3	Houghton Bay Culvert	C31040	7,400	2,900	45,200	18,250
4	Lyall Bay West Culvert	F34014	19,500	230	378,000	2,975
5	Lyall Bay East Culvert	G37050	2,300	145	10,275	2,950
6	Hataitai Culvert (Evans Bay)	K35037	21,000	250	182,500	3,900
7	Miramar Culvert (Evans Bay)	J40010	1,000	97	71,750	3,775
8	Killburnie Culvert (Evans Bay)	--	no data	no data	no data	no data
9	Cobham Culvert (Evans Bay)	J37001	1,000	84	24,600	4,150
10	Overseas Passenger Terminal	Q32035	21,150	590	129,000	11,000
11	Tory Street Culvert	Q30026	4,000	57	79,350	4,075
12	Taranaki Street Culvert	Q30017	9,800	560	47,600	12,500
13	Te Aro Culvert at Jervois Quay	Q29110	15,000	475	295,000	5,400
14	Harris Street Culvert	R29028	1,000	570	27,800	7,200
15	Waring Taylor Culvert	S29079	4,800	595	39,500	12,000
16	Bowen Street Culvert	S29091	3,150	585	76,500	6,525
17	Davis St Culvert (Aotea/Waterloo Quay)	V32022	13,500	485	35,250	8,150
18	Thorndon Quay Culvert (Aotea Quay)	W31010	5,900	480	37,750	9,150
19	Kaiwharawhara Stream*	Y33052	2,750	2,450	21,700	34,500
20	Ngauranga Stream*	AC41016	1,000	590	7,250	11,750

[2] The Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MfE 2003) recommend the use of *enterococci* as indicator organisms in marine bathing water and faecal coliforms as indicators in shellfish collection waters. In freshwaters *E. coli* are the preferred indicator organism.

[3] An analysis of the results from 2000 to 2008 indicates that while 12 of the sites are potentially affected by seawater at high tide, that effect is minor and has not significantly influenced median indicator bacteria results. That analysis also showed that samples collected in wet weather (more than 2mm rain in previous 12 hours) had a median value 4 to 10-fold higher than the median of dry weather samples.

A median faecal coliform concentration significantly in excess of 1000/100ml in stormwater may indicate an ongoing wastewater leak (exfiltration) in the catchment. A 95-percentile value over 10,000/100ml suggests either a significant wastewater leak, or significant wet weather wastewater overflows.

3.3.3 General water quality and trace metal content of stormwater

General water quality and trace metals are monitored twice yearly (at least once each year in wet weather) in stormwater at the Evans Bay Culvert (Hataitai), Waring Taylor Culvert, Overseas Passenger Terminal Culvert, Houghton Bay Culvert and the Island Bay Culvert. Results of monitoring from 2002 to 2008 are summarised in Table 3.2.

The results show that total suspended solids (TSS) and BOD_5 concentrations are generally low in Wellington's urban stormwater. The highest TSS concentrations were recorded at the Houghton Bay culvert which drains a steep catchment including the closed Houghton Bay Landfill[4]. Nutrients concentrations (TKN and TP) are moderately elevated, and highest in Houghton Bay Culvert.

Of the metals tested in Wellington stormwater only copper and zinc were frequently elevated above water quality guidelines. Some dilution in receiving waters, typically of the order 10 to 20-fold, would be required to achieve compliance with receiving water trigger values for these metals.

3.3.4 Persistent organic compounds

Wellington City Council has not routinely monitored persistent organic compounds in stormwater (but monitoring of PAHs is now proposed at selected sites – see section 8.2). GWRC has undertaken limited monitoring of organic compounds (including PAHs, PCBs, organochlorine pesticides and chlorophenols) in its urban stormwater monitoring investigation, reported by Kingett Mitchell (2005).

That investigation detected elevated levels of PCBs and DDT metabolites (the latter an organochlorine pesticide) both dissolved in stormwater and attached to particulate material carried by stormwater, but since neither has been used in New Zealand since the 1980s, this contamination is thought to be historical and concentrations are expected to gradually decrease over time. Chlorophenol compounds (historically used in timber preservation) were found only at low concentrations.

PAHs were detected at most sampling locations and while concentrations in stormwater were mostly lower than ANZECC (2000) receiving water trigger levels, the concentration in particulate material carried by stormwater frequently exceeded ANZECC (2000) sediment quality trigger levels. The profile identified appeared to reflect emission of PAHs from motor vehicles. PAH loads in stormwater runoff currently contribute to the contamination of marine sediments in Wellington Harbour, hence the need for ongoing monitoring.

[4] Leachate from Houghton Bay Closed Landfill is collected by a leachate system and directed to the wastewater network for treatment at the Moa Point WWTP. However during periods of sustained rainfall the leachate flow is greatly increased by stormwater infiltration and excess flow is diverted into the stormwater drain and discharged to Houghton Bay. This probably accounts for the relatively high suspended solids and metals levels recorded at times in Houghton Bay Stormwater.

Table 3.2: Summary of WCC urban stormwater quality results from 11 samples collected at 6 monthly intervals from 2002 to 2008. GWRC stormwater monitoring results, where available, are included for comparison (all data are g/m^3 except pH; metal results are "total" metals except for the GWRC results which are "dissolved" metals).

	Evans Bay (Hataitai)		Waring Taylor			OPT		Houghton Bay		Island Bay			Owhiro Bay
Contaminant	median	maximum	median	maximum	GW 12/5/03	median	maximum	median	maximum	median	maximum	GW 24/8/02	GW 9/6/02
TSS	35	170	17	61	63	12	78	41	267	34	91	76	17
BOD	<2	6	<2	3	--	<2	11	5	10	2	8	--	--
COD	75	1420	75	1000	--	75	1590	75	184	75	1180	--	--
TKN	0.80	8.20	0.50	1.10	0.405	0.60	1.50	2.55	28.9	0.50	2.80	1.70	0.5
TP	0.100	0.510	0.065	0.110	0.192	0.120	0.573	0.114	1.40	0.05	0.347	0.439	0.091
pH	8.0	8.2	8.0	8.1	6.8	7.8	8.4	7.8	8.0	8.0	8.4	6.9	7.7
Oil & grease	<10	<10	<10	13	--	<10	56	<10	30	<10	56	--	--
Arsenic	<0.05	<0.05	<0.05	<0.05	0.002	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.001	0.001
Cadmium	<0.003	<0.003	<0.003	<0.003	<0.00005	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.00005	<0.00005
Chromium	<0.03	<0.03	<0.03	<0.03	0.0053	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.0006	0.0010
Copper	<0.03	<0.03	<0.03	<0.03	0.0225	<0.03	0.069	<0.03	0.252	<0.03	0.069	0.0069	0.0040
Iron	<1.0	6.0	<1.0	<1.0	0.08	<1.0	2.6	2.5	74	<1.0	<1.0	0.04	<0.02
Lead	<0.005	0.019	<0.005	0.007	0.0025	<0.005	0.023	0.009	0.217	<0.005	0.015	0.0003	0.0008
Nickel	<0.03	<0.03	<0.03	<0.03	0.0009	<0.03	0.04	<0.03	<0.03	<0.03	<0.03	<0.0005	<0.0005
Mercury	<0.0008	<0.0008	<0.0008	<0.0008	<0.00008	<0.0008	<0.001	<0.008	<0.001	<0.0008	<0.0010	<0.00008	<0.00008
Zinc	<0.05	0.170	<0.05	0.100	0.108	0.067	0.240	<0.05	0.240	<0.05	0.227	0.097	0.024
Cyanide	<0.002	<0.01	<0.001	<0.01	--	<0.005	0.02	<0.01	0.06	<0.001	<0.01	--	--

3.4 Nature of receiving environment

3.4.1 Sensitivity of receiving environment

The Resource Management Act requires regard to be had the sensitivity of receiving environments when considering the environmental effects of discharges of contaminants.

The "sensitivity" of a given receiving environment (i.e. its susceptibility to adverse effects) is dependent upon site characteristics including the nature and extent of water movement at the discharge point (which determines the degree of contaminant deposition or dispersion), the nature of the biological communities present in the vicinity of an outfall (e.g. the presence of rare species or assemblages could make the receiving waters "sensitive"), and human uses or values associated with the area (e.g. passive or active recreation, shellfish gathering, Maori cultural and spiritual values, marine reserves).

Each of these factors is briefly considered below. A summary of receiving environment characteristics is brought together with stormwater catchment characteristics in Table 3.3.

3.4.1.1 Water movement

The majority of contaminants in stormwater discharges are attached to the particulate fraction and a relatively small proportion is dissolved in stormwater. Consequently, beyond the discharge outlet, sediment, organic matter and associated toxic constituents tend to drop out of the water column and settle towards the bed of the water body.

In general terms, it can be expected that contaminants in stormwater discharges to the exposed waters of the South Coast (e.g. Owhiro Bay, Island Bay, Houghton Bay, Lyall Bay) will be more rapidly diluted and dispersed than contaminants discharged to the more sheltered waters of Lambton Harbour and Evans Bay. This is evidenced by the predominantly rocky, gravel or coarse sand seabed on the South Coast compared with the fine silt present on the seabed in the more sheltered parts of Wellington harbour. Oceanographic studies of Lambton Harbour and Evans Bay indicate that these areas are characterised by restricted circulation patterns (Booth 1975; Health 1977) which may make them susceptible to the build-up of pollutants. Put another way, the dispersive receiving environments of the South Coast are less "sensitive" than the depositional receiving environments of Wellington Harbour. Unfortunately, it is the stormwater discharges to Wellington Harbour that tend to have the greatest contaminant loads, reflecting a relatively high intensity of land use and traffic density in Harbour catchments.

3.4.1.2 Biological communities

There have been a number of biological studies undertaken at specific locations within Wellington Harbour and on the South Coast and, in general terms, the marine fauna and flora of Wellington Harbour and South Coast are well known (see review paper of Wear and Haddon, 1992). Many studies have been undertaken in connection with assessments of specific development proposals e.g. dredgings, marina and port development. The only field studies that have been undertaken with a view to assessing the effects of stormwater discharges on marine biota are those of Bolton-Ritchie and her co-workers, referred to below.

To the extent that stormwater discharges are to the near shore intertidal and sub-tidal zones, generally regarded as the most biologically diverse and productive parts of the coastal marine area, the receiving waters can be considered "sensitive". However, the available information does not suggest that any of the receiving environments for Wellington stormwater discharges are particularly sensitive in terms of the species or communities present in the vicinity of outfalls. On the other hand, there is reason to believe that some areas are relatively "insensitive" receiving environments due to the degree of modification or disturbance that has taken place in the past or is currently taking place e.g. the areas adjacent to wharves where sediments are regularly stirred by ship propellers.

3.4.1.3 Human uses and values

Some receiving environments are particularly sensitive by virtue of the human uses and values (including cultural and spiritual values) associated with them. This consideration was the principal driver behind the establishment of works priorities for the elimination of wastewater contamination from the City's coastal stormwater discharges.

The Island Bay/Owhiro Bay and Seatoun/Eastern Bays areas are particularly sensitive due to the presence of traditional shellfish gathering, rock fishing and spear fishing areas, and the Island Bay/Owhiro Bay area also lies within the Taputeranga Marine Reserve. (Note, fishing and shellfish collection is no longer permitted within the area covered by the marine reserve.)

Bathing areas such as Island Bay, Lyall Bay, Princess Bay, Seatoun (Eastern Bays), Hataitai Beach, Balaena Bay and Oriental Bay are also "sensitive" areas from the points of view of public health risk to bathers (microbial contamination) and the potential for "floatables" to find their way into receiving waters either by way of wastewater overflows or runoff from roads, with consequent adverse effects on aesthetic values.

Floatables may also adversely affect the enjoyment of the environment by active recreationists (e.g. fishers, boaters) and passive recreationists and in this respect areas with a high density of recreational use (e.g. Oriental Bay, Chaffers marina, the Overseas Passenger Terminal and the Wellington Waterfront) can also be regarded as "sensitive" receiving environments relative to say the Operational Port Area which has restrictions on public access.

Table 3.3: Summary of major stormwater discharges, showing catchment and receiving water characteristics

	Stormwater Discharge	Catchment Characteristics						Receiving Environment	
		Predominant use	Constructed wastewater overflow	Traffic volume	Stormwater		Sediment Trap (volume m³)	Exposure to waves and currents[a]	Human uses and values
					Flow (m³/s) 2-year ARI	95%ile FC/100ml value for year to June 08			
1	Owhiro Stream*	Residential (& landfills)	Yes	moderate	20.1	1,775		very exposed	marine reserve (SFRG: Fair)[b]
2	Island Bay Culvert	residential	Yes	moderate	14.4	2,050	15	very exposed	marine reserve (SFRG: Fair)[b]
3	Houghton Bay Culvert	Residential (& landfill)	Yes	low	3.2	18,250		very exposed	marine reserve &surfing/bathing
4	Lyall Bay West Culvert	residential	Yes	low	5.6	2,975		very exposed	bathing (SFRG: Good)[b]
5	Lyall Bay East Culvert	commercial	No	low	2.9	2,950		very exposed	bathing (SFRG: Fair)[b]
6	Hataitai Culvert (Evans Bay)	residential	Yes	moderate	5.2	3,900		sheltered	general amenity
7	Miramar Culvert (Evans Bay)	commercial	Yes	moderate	12.8	3,775	2 & 100	sheltered	general amenity
8	Kilbirnie Culvert (Evans Bay)	residential	No	moderate	2.7	no data		sheltered	general amenity
9	Cobham Culvert (Evans Bay)	commercial	No	moderate	3.1	4,150		sheltered	general amenity
10	OPT	commercial	Yes	high	15.5	11,000		sheltered	general amenity
11	Tory Street Culvert	commercial	No	high	2.9	4,075		sheltered	general amenity
12	Taranaki Street Culvert	commercial	Yes	high	3.7	12,500		sheltered	general amenity
13	Te Aro Culvert	residential	Yes	high	8.1	5,400	30 & 30	sheltered	general amenity
14	Harris Street Culvert	commercial	No	high	1.4	7,200		sheltered	general amenity
15	Waring Taylor Culvert	commercial	Yes	high	2.5	12,000	30	sheltered	commercial port
16	Bowen Street Culvert	commercial	Yes	high	4.2	6,525		sheltered	commercial port
17	Davis St Culvert	commercial	Yes	high	6.0	8,150	2	sheltered	commercial port
18	Thorndon Quay Culvert	residential	Yes	high	3.2	9,150	12 & 8	sheltered	commercial port
19	Kaiwharawhara Stream*	residential	Yes	high	29.9	34,500	600	moderately sheltered	general amenity
20	Ngauranga Stream*	commercial	Yes	high	23.7	11,750	600	moderately sheltered	general amenity

a Very exposed high energy areas such as the South Coast are "dispersive:" environments in which contaminants are rapidly diluted and dispersed. Sheltered waters such as Evans Bay and inner Lambton Harbour are "depositional" environments where contaminants tend to settle and accumulate.
b SFRG = suitability for recreation grade (from MfE 2003)
* refer Section 1.2

3.4.2 Marine sediment quality and benthic ecology

There have been a number of general studies of metal contamination of sediments in Wellington Harbour aimed at elucidating historic trends in contamination and the existing pattern of contamination. Studies of the wider harbour include Stoffers et al (1986), Glasby et al (1990), Dickinson et al (1996), Pillotto et al (1998) and the recent study undertaken by Greater Wellington Regional Council (GWRC 2008).

Studies of marine sediments near stormwater outfalls include Pilotto (1996), Pilotto et al (1998), Bolton-Ritchie et al (1999a and 1999b), Bolton-Ritchie (2003), Aherns et al (2007), and Stephenson (2007)

3.4.2.1 Near field studies

Bolton-Ritchie's PhD thesis (2003) is specifically focused on the effects of stormwater discharge on the nearshore benthic environment of inner Wellington Harbour. It addresses "*spatial and temporal sedimentological (sediment structure i.e., grain size and organic matter content), chemical (As and the metals – Cr, Cu, Ni. Pb and Pb) and biological (macrobiota) characteristics of the nearshore benthic environment in the immediate vicinity of a number of inner harbour stormwater outlets*".

The study covered eight stormwater outlets including two at Aotea Quay (Tinakori and Glenmore catchments) two at Queens Wharf (Waring Taylor Street and Hunter Street catchments), two in Lambton Harbour (Harris St and OPT catchment) and two in Evans Bay (Kilbirnie catchment).

Control sites were located at Aotea Quay, Queens Wharf and Evans Bay. It was intended that the control sites would be comparable with the outlets with regard to physical aspects (wind, tide, wave, substrate, depth) yet unaffected by stormwater discharge. They were intended to reflect the present state of the nearshore environment, regardless of its modified status as a consequence of anthropogenic activity.

The results of the Bolton-Ritchie study (see metal results summary in Table 3.4) indicate that:

- Stormwater discharge has resulted in organic and metal enrichment of the sediments in the vicinity of the outlets. In general the highest level of enrichment occurs close to, and decreases with increasing distance from the outlet. The outward extent of enrichment from an outlet is both outlet and contaminant specific.
- For organic matter and metals the extent of enrichment varied between 10 and >45m from the outfall.
- The OPT site was the most contaminated with organic matter and metals. At 1.5 metre in front of the outfall the sediments contained 72% organic material. Maximum metal concentrations were arsenic 124 g/m^3, chromium 124 g/m^3, copper 754 g/m^3, nickel 56 g/m^3, lead 1098 g/m^3, and zinc 1609 g/m^3.
- As a result of the stormwater discharge the biological community in the vicinity of all outlets was disturbed. The extent of impact, based on the presence and abundance of macrobiota, varied between 10 and 34m. (However a greater extent of influence, on unmeasured biological parameters such as stress, behaviour, physiology and life history cannot be discounted).

The author concluded that contaminants discharged in stormwater do accumulate in the sediments in proximity to stormwater outlets and the macrobiota in the vicinity of the outlets is impacted by stormwater discharge.

On the face of it the data suggest that metal toxicity is a significant causative factor in respect of the macrobiota changes observed in the vicinity of the outfalls. Indeed some of the sediment samples have copper, lead and zinc levels up to 6 times higher than the probable effects level ISQG-High recognised by the ANZECC Guidelines[5] However the biological effects observed could be partially attributable to changes in sediment grain size, and/or organic enrichment and/or salinity gradients.

[5] The existence of sediment metal levels as high as this does not necessarily "translate" to the existence of toxic effects. For example sediments from Aotea Quay area with metal levels approaching ISQG-High levels were subject to elutriate testing by NIWA (1996) and it was concluded that the material did not pose a threat as a consequence of elevated metal levels. Sometimes metals are "tied up" (i.e. not bio-available) as a result of complexing with organic or inorganic material within the sediments.

Table 3.4: Minimum and maximum metals concentrations with comparison to ANZECC sediment quality criteria (Blue values exceed ISQG-Low and red values exceed ISQG-High) – from Bolton-Ritchie (2003) raw data.

Outlet	Site	n	Cr (min-max)	Cu (min-max)	Pb (min-max)	Zn (min-max)
Aotea Quay	AQ-1	9	67.4 – 78.7	63.3 – 128	90.5 – 174.2	208.1 – 429.7
	AQ-2	77	63.3 – 92.6	55.2 – 253.3	95.3 – 1,367.5	208.3 – 712.8
	AQ-3	77	60.6 – 106.9	52.8 – 111.3	64.9 – 182.6	192.5 – **316.5**
Queens Wharf	Q-1	8	67.6 – 100.9	175.4 – 794.1	191.3 – 1,054	175.4 – 794.1
	Q-2	83	67.5 – 98.8	165.8 – 675.1	160.3 – 510.9	33.5 – 561.2
	Q-C	9	69.4 – 83.3	161.2 – 252.9	160.3 – 279.9	263.2 – 447.7
Harris Street	FK	12	61.3 – 79.2	96.8 – 149.7	171.3 – 319.7	249 – 396.9
OPT	OPT	9	78.7 – 123.8	184.5 – 753.8	180.8 – 1,098	362.4 – 1,609
Evans Bay	EB-1	21	65.5 – 96.0	58.7 – 157.8	95.4 – 313.7	163.8 – 383.6
	EB-2	99	73.5 – 123.2	56.9 – 302.8	124.3 – 619.2	227 – 962.9
	EB-C	100	67.7 – 714.9	49.2 – 104.5	110.2 – 205.2	212.4 – 327.8
ANZECC (2000)	ISQG-Low		80	65	50	200
	ISQG-High		370	270	220	410

More recently WCC commissioned investigations into marine sediment quality and benthos in the vicinity of the Miramar stormwater outfall following concern about odours and conspicuous discharges (hydrocarbons) from the outfall during 2006, which were thought to be arising from a former gasworks site in the catchment. An investigation of marine sediment quality undertaken by NIWA during July 2007 (Ahrens et al 2007) identified significant organic contamination (phenol, TPH and PAH) in subtidal marine sediments within about 175 metres of Miramar stormwater culvert. Ahrens et al concluded there was little indication of recent significant contamination by gasworks wastes. The TPH results were indicative of contamination by heavy mineral oils (which is consistent with the observation of oil in a number of core samples taken within 50m of the outfall). The authors also concluded that the observed PAH concentrations and compositional signature suggests significant inputs of coal-tar based roading material. The latter is presumably a legacy from older coal-tar sealed roads in the Miramar catchment.

A survey of marine benthos undertaken by Coastal Marine Ecology Consultants during July 2007 (Stephenson 2007) found that the impact of discharges from the Miramar stormwater culvert on the marine benthic ecology is restricted to a radius of little more than 30 metres from the outfall.

3.4.2.2 Far field studies

One of the objectives of Greater Wellington's "Wellington Harbour marine sediment quality investigation" (GWRC 2008) was to establish a programme that could detect long term changes in sediment quality and benthic community health. Sites were selected on the basis that they would be suitable for long term monitoring, that they would be representative of the area of concern and that they would reflect far-field effects rather than effects in areas close to discharge points. This is consistent with Greater Wellington's focus on the health of the wider harbour environment.

Seventeen subtidal sampling sites were located across the harbour to provide a comprehensive assessment of surface sediment quality.

Investigation results show that concentrations of lead, mercury, and to a lesser extent copper and zinc, are present above sediment quality guidelines in the subtidal sediments of various parts of Wellington Harbour, especially those adjacent to Wellington City.[6] Flourene, phenanthrene, benzo[a]anthracene,

[6] GWRC compared sediment quality results with both the ANZECC ISQG-Low and ANZECC ISQG-High criteria, as well as the Auckland Regional Councils "Environmental Response Criteria" (ERC). The latter are considered to provide a conservative, yet practical early warning of environmental degradation which allows time for investigations into the causes of contamination to be carried out and the options for limiting degradation to be developed. Both guidelines are considered to be robust and conservative (i.e. they err on the side of environmental protection). They are not "pass or fail" numbers but are intended to be used as part of a "weight of evidence" approach to evaluating potential effects of contaminants on benthic biota.

and total high molecular weight PAH are above sediment quality guidelines in southern Evans Bay. Total high molecular weight PAH also exceeds guidelines in northern Evans Bay and at the entrance to the Lambton basin. Total DDT is present above the guidelines over much of the harbour. Concentrations of other heavy metals, organochlorine pesticides and PAHs are currently below guidelines levels in subtidal sediments of the harbour (refer to Appendix III for a summary of Wellington Harbour marine sediment quality results and comparison with sediment quality guidelines).

The benthic faunas present at the marine sediment quality sampling sites are considered to be variants of an inner harbour subtidal fine sediment community occurring in water depths greater than 10 metres. The benthic ecology data show that, although concentrations or several contaminants are above sediment quality guidelines, there is no clear evidence any of the contaminants have resulted in significant adverse effects on the benthic community structure at those sites as of November 2006.

The strong offshore gradients in contaminant concentration and the chemical nature of some of the contaminants in the sediments provide a clear indication of their land-based origin. The review of available stormwater quality data from the harbour's catchment (see above) indicates that urban stormwater is the principal agent in the transport of the majority of these contaminants to the harbour and seabed, either directly or by way of urban streams.

The authors of the GWRC report recommend a second survey of sediment chemistry and benthic ecology, using the same methodologies, is undertaken in 2011 at 9 or 10 of sites used in the study described above, and subsequent surveys at 5 or 6 year intervals. (In 10 years time it is anticipated that GWRC will have completed and reported on two more harbours survey's, giving a far better understand on contaminant levels, rates of contaminant accumulation and the potential for adverse effects on marine benthos in the future).

4 Planning context

4.1 Introduction

Discharges to the coastal marine area are governed by the provisions or requirements of:

- The Resource Management Act 1991 (RMA).
- The New Zealand Coastal Policy Statement (NZCPS).
- The Wellington Regional Policy Statement (RPS).
- The Regional Coastal Plan (RCP) for the Wellington Region and (because in some circumstances the point of discharge is to land adjacent to the coastal marine area) the Discharge to Land Plan (DLP) for the Wellington Region.
- The Marine Reserves Act 1971.

This section identifies the key statutory provisions and rules pertaining to management of stormwater discharges in the Wellington Region.

4.2 Resource Management Act Requirements

The RMA sets out the circumstances in which resource consents for activities are required. The following sections are relevant to the current application:

Section 12 sets out he restrictions on the use of the coastal marine area as follows:

> *(3) Without limiting subsection (1), no person may carry out any activity—*
> *(a) In, on, under, or over any coastal marine area; or*
> *(b) In relation to any natural and physical resources contained within any coastal marine area,—*
> *in a manner that contravenes a rule in a regional coastal plan or a proposed regional coastal plan unless the activity is expressly allowed by a resource consent or allowed by section [20A] (certain existing lawful activities allowed).*

Section 15 sets out the restrictions on the discharge of contaminants into environment

> *(1) No person may discharge any—*
> *(a) Contaminant or water into water; or*
> *(b) Contaminant onto or into land in circumstances which may result in that contaminant…entering water.*
> *…*
> *unless the discharge is expressly allowed by a rule in a regional plan and in any relevant proposed regional plan, a resource consent, or regulations.*

Thus, a resource consent will be required if each proposed discharge of Wellington City stormwater to the coastal marine area of Wellington Harbour and the South Coast or land adjacent to this, is not a permitted activity under the RCP or DLP.

4.3 Regional Coastal Plan and Discharges to Land Plan

The relevant plan for the coastal marine area in the RCP, which became operative in June 2000.

Chapter 10 of the RCP addresses discharges to land and water. Under this chapter, Rule 53 makes the discharge of stormwater to the coastal marine area (CMA) a permitted activity, providing the discharge meets specified conditions. If Rule 53 does not apply Rules 57, 58 or 61 apply. (Note the Rules that apply to Areas of Significant Conservation Value are not relevant in this case because none of the discharges are into the areas identified in Appendix 2 of the RCP). Rules 53, 57, 58 and 61 are as follows:

Rule 53 Stormwater

Any discharge of stormwater onto land or into water in the coastal marine area from any motorway, road, street, railway line, roof, yard, paved surface, breakwater, jetty, boat shed, or any other structure is a Permitted Activity, provided it complies with the conditions specified below.

Conditions

(1) The discharger shall adopt the best practicable option to ensure that after reasonable mixing the stormwater discharges will not give rise to all or any of the following effects:

- *the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;*
- *any conspicuous change in the colour or visual clarity;*
- *any emission of objectionable odour;*
- *the rendering of fresh water unsuitable for consumption by farm animals;*
- *any significant effects on aquatic life*

(2) The stormwater collection systems and pipelines will be constructed and maintained in an efficient operating condition.

(3) The stormwater shall be discharged at a rate that does not cause significant erosion.

Rule 57 Stormwater Discharges (other than human sewage) with significant adverse effects outside any Area of Significant Conservation Value

Any discharge onto land or into water in the coastal marine area … which is not a permitted activity described in Rules 53-56 and which is a discharge of the type referred to in section 107(1) of the Resource Management Act 1991 is a Discretionary and Restricted Coastal Activity.

Rule 58 Discharge of human sewage (except from vessels) outside any Area of Significant Conservation Value

Except within an Area of Significant Conservation Values, any discharge of human sewage to the coastal marine area (except from vessels) which has not passed through soil or wetland is a Discretionary and Restricted Coastal Activity.

Rule 61 Other activities involving discharges to land and water outside Areas of Significant Conservation Value

Any discharge of a contaminant or water onto land or into water in the coastal marine area, outside any Area of Significant Conservation Value:

- *not provided for in Rules 53-60 or 62 or any other rules in this Plan; or*
- *which cannot meet the requirements of those rules;*

is a Discretionary Activity.

As detailed in the application form there are 3 categories of discharges comprised in this application. The discharges in Category 1 are from parts of the network where there are known, constructed overflows, from the sewerage network. Whilst significant advancements have been achieved in reducing incidents of wastewater contamination, they have not been eliminated completely from those stormwater discharges with a constructed overflow. Because of this, these discharges are Discretionary and Restricted Coastal Activities under Rule 58 of the RCP.

All other discharges (in Categories 2 and 3) are applied for under Rules 57 or 61 and are discretionary activities. This is notwithstanding that some of the discharges can not be conclusively shown as not meeting the permitted activity rule. However such discharges are included out of caution and in acknowledgement that from time to time in the future it may be shown that the conditions of the permitted activity Rule are not met.

The DLP is also relevant for the limited cases where the discharges are to land adjacent to the CMA. Rule 2 of the DLP makes the discharge of stormwater, that is not a permitted activity, a discretionary activity. If human sewage is present in the discharge then under Rule 8 of the DLP it is also a discretionary activity. This is notwithstanding that some of the discharges can not be conclusively shown as not meeting the permitted activity rule. Again such discharges are included out of caution and in acknowledgement that from time to time in the future it may be shown that the conditions of the permitted activity Rule are not met.

4.4 Marine Reserves Act 1971

The Marine Reserves Act 1971 (MRA) provides for the setting up and management of areas of the sea and foreshore as marine reserves for the purpose of preserving them in their natural state as the habitat of marine life for scientific study. Under the MRA, the Taputeranga Marine Reserve was established in July 2008 on the south coast of Wellington, extending 3.8km from Houghton Bay to the old Owhiro Bay quarry, and covering approximately 854ha.
The Island Bay culvert and the Houghton Bay culvert discharge stormwater into the Taputeranga Marine Reserve, therefore the MRA is of some relevance to the current proposal. Under section 18I(2) of the MRA:

> Every person commits an offence against this Act and is liable to imprisonment for a term not exceeding 3 months or to a fine not exceeding $50,000, or to both, who, without lawful authority or reasonable excuse, discharges or causes to be discharged or deposits, whether directly or indirectly, in or into a marine reserve any toxic substance or pollutant or other substance or article of any kind injurious to marine life.

The MRA does not establish a procedure independent of the RMA for approvals/ obtaining 'lawful authority'. However the Order in Council formalising the notification of the Taputeranga Marine Reserve acknowledges RMA consents as being lawful. These consents, if obtained will authorise the discharges under the MRA.

5 Assessment of effects on the environment

This section describes the actual and potential effects of the stormwater discharges to the coastal environment and adjacent land, as required by section 88 of the Resource Management Act 1991.

5.1 Contact recreation and shellfish gathering criteria

This section considers the potential effects of contaminated stormwater discharges on compliance with the RCP water quality criteria for coastal waters managed for contact recreation and for shellfish gathering/consumption. It should be noted that GWRC has not formally classified the marine waters of the region so the criteria referred to in the RCP have the status of guidelines rather than rules.

All of Wellington Harbour and the waters of the South Coast are being managed for contact recreation. In addition, nearshore waters (extending 200m out from the shore) along the north eastern shoreline of Miramar Peninsula (Mahanga Bay), in the vicinity of Tarakena Bay/Palmer Head and Te Raekaihau, and around Taputeranga Island and the Sirens Rocks as well as the rocky coastline west of Owhiro Bay are to be managed for shellfish gathering (refer Figure 5.1).

For waters managed for contact recreation purposes the relevant guideline is that:

> *The median bacterial content in samples of water taken over the bathing season do not exceed:*
>
> *• either 150 faecal coliforms per 100 mL (minimum of five samples taken at regular intervals not exceeding one month, with four out of five samples containing less than 600 faecal coliforms per 100 mL); or*
>
> *• 35 enterococci per 100 mL over the bathing season (any individual sample should not exceed 153 enterococci per 100 mL).*

For shellfish gathering waters the relevant guideline is:

> *"The median bacterial content in samples of water taken over the gathering season shall not exceed 14MPN faecal coliforms per 100mls (with 9 out of 10 samples containing less than 42MPN faecal coliforms per 100mls)."*

The faecal coliform data summarised in Section 3.3.2 highlights the improvements achieved by WCC's SPE project over the last 15 years. The widespread wastewater pollution of stormwater that existed in Wellington in 1993 is now much reduced. Table 2.1 identifies 14 of 19 stormwater discharges subject to wastewater pollution in the year to June 1993 compared with 2 of 19 in the year to June 2008.

At nearly all stormwater sites monitored during 2007 and 2008 compliance with the contact recreation faecal coliform median guideline and 80-percentile guidelines would be achieved after less than 20-fold dilution in receiving waters. That level of dilution is likely to occur within a 'reasonable mixing' zone, that is within a 30 to 50m radius of the outlet.[7]

At most sites the stormwater discharges would comply with the shellfish gathering faecal coliform median and 90-percentile guidelines after 250-fold dilution. That level of dilution is likely to be available as none of the major stormwater discharges are located in the vicinity of water managed for shellfish gathering. The closest is probably the shellfish gathering waters around Taputeranga Island in Island Bay, which extend to within approximately 200m of the Island Bay Culvert, but in this case the strong tidal currents that run between the shore and the Island are expected to provide a high level of dilution. (It is noted that this area now falls within the Taputeranga Marine Reserve and that shellfish collection is no longer permitted, and that filter feeding shellfish such as the green-lipped mussel are largely absent from the southern coastline).

---

[7] A quantitative dye study undertaken for the Karori WWTP discharge to Wellington's South Coast found that under relatively calm conditions an 80-fold dilution is normally achieved at the edge on an 100m mixing zone (Cawthron 2003), indicating that a 20-fold dilution could readily be achieved at the edge of a 50m mixing zone.

GWRC routinely monitors recreational shellfish gathering waters at two Wellington City sites, these being Shark Bay and Mahanga Bay. These sites are sampled weekly during 1 November to 31 March inclusive and at least monthly during the remainder of the year. Both sites fully complied with the recreational shellfish gathering water quality guidelines for the 2007/08 summer (GWRC 2008a).

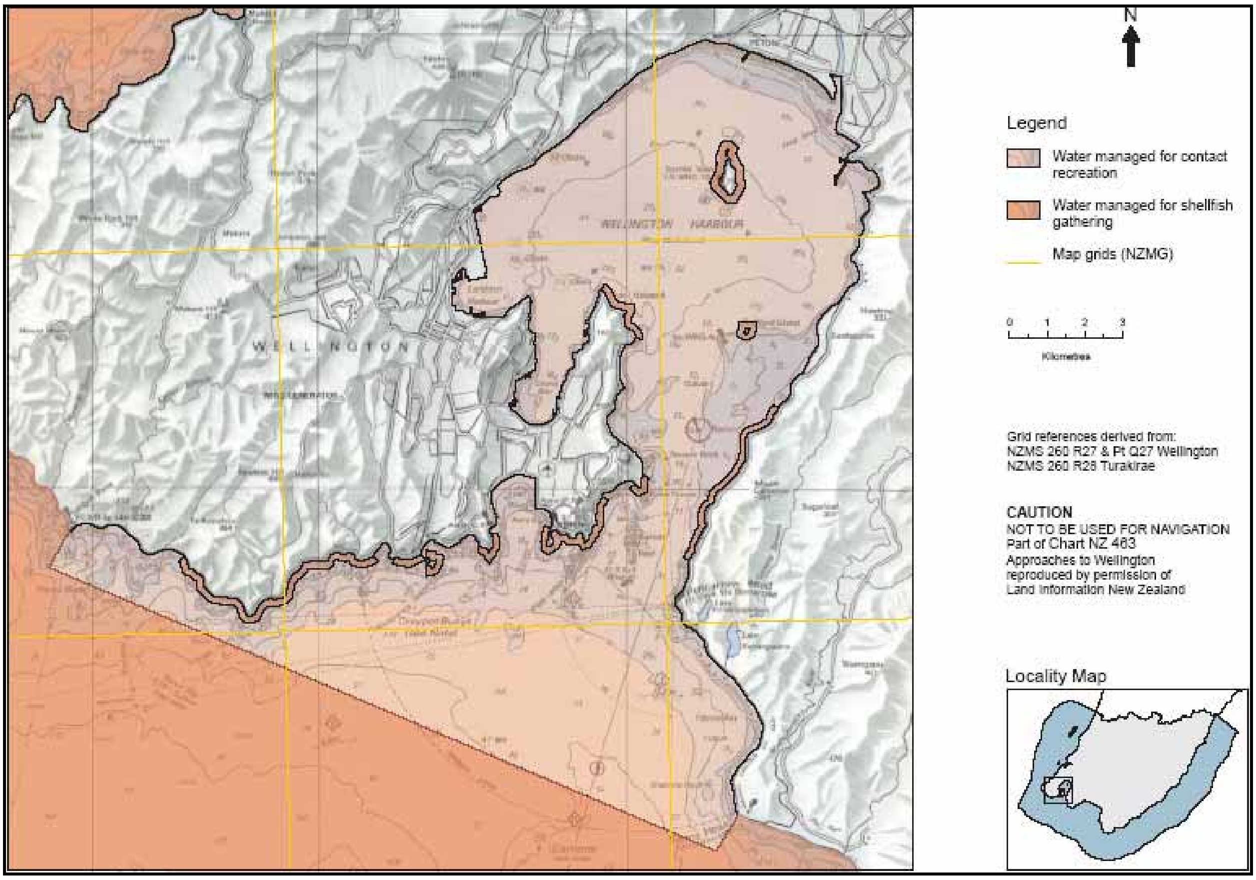

Figure 5.1: Coastal Water Quality Classes – waters managed for contact recreation and shellfish gathering purposes (Map 8D of Regional Coastal Plan)

The contact recreation microbiological criteria in the RPS have been superseded by the MfE (2003) Recreational Water Quality Guidelines, which have been adopted by GWRC. The current GWRC bathing water quality monitoring programme, developed in accordance with MfE (2003), provides a robust assessment of the microbiological health risk for contact recreational uses of Wellington Harbour and the South Coast. This assessment brings together the results of long term indicator bacteria monitoring and sanitary inspections to provide a “suitability for recreation grade” (SFRG) for each bathing beach site. Sites are sampled weekly during the bathing season.

The programme includes a three-tier management framework: Green/Surveillance; Amber/Alert; Red/Action, based on the result of weekly monitoring. Surveillance mode indicates normal (weekly) sampling of bacteriological levels. The alert mode is triggered when a single bacteriological sample exceeds 140 enterococci/100ml. Under the alert mode sampling frequency is increased to daily. The action mode is triggered when two consecutive single samples (within 24-hours, or as soon as is practicable) exceed 280 enterococci/100ml. Under the action mode GWRC and Regional Public Health warn the public, using appropriate methods, that the beach is unsuitable for recreation and arrange to have warning sign erected.

The results for the 2007/08 bathing season show that 11 of the 22 marine sites monitored in Wellington City exceeded the action guideline on at least one occasion (GWRC 2008a). These sites were Owhiro Bay, Island Bay at Reef Street, Island Bay at Surf Club, Lyall Bay at Tirangi Road, Seatoun Beach at

Inglis Street, Seatoun Beach at Wharf, Balaena Bay, Oriental bay at Band Rotunda, Oriental Bay at Wishing Well, Oriental Bay at Freyberg Beach, and Aotea Lagoon. The majority of these breaches coincided with more than 10mm of rainfall in the 72 hours prior to sampling, i.e., they are associated with stormwater runoff from the City. WCC collected additional samples following all breaches. The results of most of these follow-up samples complied with the surveillance guideline, indicating that no further management action is required. The exceptions were at Owhiro Bay and Island Bay at Surf Club where further exceedances were recorded, and health warning signs were subsequently erected. At Island Bay the breaches are attributed to a sewage pump station overflow caused by heavy rain. At Owhiro Bay the cause was not determined.[8], [9]

The 2007/08 results resulted in one site (Oriental Bay at Wishing Well) receiving a SFRC grade of poor, indicating an increased risk to bathers due to significant faecal contamination.[10]

These results indicate that despite the improvements made in Wellington stormwater quality in recent years, stormwater continues to have some effect on near shore water quality at some Wellington bathing beaches during and after sustained wet weather. Nevertheless, the risks to public health are appropriately mitigated by the staged management response outlined above, which may from time to time result in the erection of public health warning signs at bathing beaches. An appropriate remediation response is provided by WCC as part of the ongoing operation of the stormwater and wastewater collection systems.

5.2 Effects on visual, aesthetic and amenity values

Under section 107 of the RMA and under the RCP the stormwater discharges should not, after reasonable mixing, cause any of the visual and/or aesthetic effects within the receiving waters covered in s107 of the RMA. These include:

- conspicuous oil or grease films, scums, foams, floatables or suspended materials
- conspicuous changes in colour or visual clarity
- objectionable odours

The total suspended solids and oil/grease content of stormwater from urban Wellington is relatively low as indicated in Table 3.2. The suspended solids content is normally lower than in natural water courses during an equivalent rainfall event. Thus, during sustained heavy rainfall the Hutt River can have a major impact on the colour and visual clarity of waters within Wellington Harbour whereas runoff from urban Wellington is unlikely to have a more than a minor effect.

Litter and floatables are an issue in urban runoff. An investigation into litter loads discharged from the Overseas Passenger Terminal culvert undertaken by Greater Wellington Regional Council and WCC suggests that floatables are well controlled by street sumps and do not result in significant visual or aesthetic effects in receiving waters.

Non floatable litter, such cigarette butts and other organic material, can pass through street sumps and may be discharged to the CMA While this material is less likely to cause visual or aesthetic effects, benthic ecology surveys (Haddon and Weir 1993, Bolton-Ritchie 2003) have reported high levels of organic matter in seabed sediments in the immediate vicinity of the large stormwater outfalls at Overseas Passenger Terminal and Aotea Quay.

No complaints relating to odour from stormwater discharges have been received by WCC. It is unlikely that offensive odour occurs in the immediate vicinity of stormwater outfalls.

[8] A sanitary survey undertaken in response to the overflow of Pump Station 37 in Island Bay identified illegal cross-connections in Trent Street, causing stormwater to overload the sewer system in heavy rain. Remedial actions were taken.

[9] A sanitary survey undertaken in response to high indicator bacteria levels at Owhiro Bay did not find the source of pollution.

[10] A sanitary survey undertaken in Oriental Bay failed to track the source of the pollution.

5.3 Effects on recreational values

Stormwater discharges from outfalls located at popular recreational beaches including Oriental Bay, Seatoun, Lyall Bay and Island Bay, can temporarily affect recreational values in surrounding coastal waters. As described in Section 5.1 above, in most cases this effect is of very short duration and does not require any management response. However, during the 2007/08 bathing season health warning signs were temporarily erected at two Wellington bathing beaches as a result of faecal contamination of bathing waters over a period of at least 2 days.[11] While WCC has significantly reduced the extent of wastewater pollution of stormwater over the last 15 years by the SPE programme, contamination still occurs from time to time as a result of extreme weather conditions or the development of faults in the stormwater or wastewater network.

These effects are appropriately mitigated by the WCC's ongoing efforts to detect and correct reticulation faults and by the GWRC/WCC bathing beach monitoring programme, which includes a management response in accordance with the Microbiological Water Quality Guidelines for Marine and Freshwater Recreation Areas (MfE 2003), (refer Section 5.1 above).

5.4 Effects on marine ecology

The *"minimum water quality criteria*" of the RCP which apply to the receiving waters include a requirement that, after reasonable mixing, the discharge is not likely to cause any significant impact on aquatic life.

Contaminated discharges to water can potentially affect aquatic life by way of:

- Temperature, pH differentials or oxygen depletion
- Nutrient enrichment, or
- Toxic effects

Discharges of stormwater runoff from urban Wellington to the Harbour or South Coast are unlikely to influence temperature, pH, dissolved oxygen or nutrient balances sufficiently to cause a significant adverse effect on aquatic life. These aspects are not discussed further in this report.

The information currently available on concentrations of metals and other toxicants in Wellington stormwater and marine sediments is summarised in sections 3.3 and 3.4. Of the metals tested in Wellington stormwater only copper and zinc were frequently elevated above water quality guidelines. Some dilution in receiving waters, typically of the order 10 to 20-fold, would be required to achieve compliance with trigger values for these metals. This level of dilution is likely to occur within a "reasonable mixing" zone. These results indicate that stormwater discharges are unlikely to have significant adverse effects within the water column after reasonable mixing.

However, there is evidence that Wellington stormwater discharges have resulted in organic and metal contamination of sediments in the vicinity of the larger inner city outfalls, and that the biological community within a 10 - 35 metre radius of those outfalls is disturbed.

Four metals (copper, lead, mercury and zinc) are present in marine sediments at far field harbour locations (well removed from discharges), at concentrations above sediment quality guidelines. Tributyltin, some of the PAHs, and DDT also exceed the guidelines at some locations. Some of these contaminants including lead, mercury, tributyltin and DDT may be largely historic and likely to decline in the future, while concentrations of others such as copper, zinc and some PAHs may increase.

---

[11] WCC maintains *permanent* health warning signs next to stormwater outfalls, where it is known there are constructed overflows from the sewerage network which result in the occasional discharge of wastewater to the stormwater system. These are distinct from *temporary* warning signs which are placed in response to significant contamination of bathing waters beyond the immediate vicinity of the stormwater outfall.

The GWRC study (GWRC 2008) did not provide any clear evidence that contaminants measured in far field marine sediments have resulted in significant adverse effects on the benthic community structure. Nevertheless it is possible that concentrations of some toxicants may be increasing, and that adverse effect may occur at some point in the future.

Sheltered areas of Evans Bay and inner Lambton Harbour are “depositional” environments where contaminants tend to settle and accumulate. Indeed the majority of Wellington Harbour is moderately sheltered and it is likely that a significant proportion of particulate material discharged to the harbour settles and accumulates within the harbour basin. A net increase in contaminant concentrations in harbour sediments would be expected if the rate of contaminant input to the harbour exceeds the rate at which contaminants are transported out of the Harbour by tidal currents, unless these sediments are sufficiently diluted by cleaner sediments discharged from the Hutt River. The GW study is designed to track contaminant concentrations over time so that increasing (or decreasing) trends can be identified and the risk to biological communities better characterised. However, as only one round has been completed to date, that information is not yet available.

The RCP requires that there be no significant adverse effects on aquatic life after reasonable mixing. It can be argued that the zone within which biological affects are apparent and possibly “adverse” identified by Bolton-Ritchie (2003) does in fact constitute a zone of reasonable mixing and that therefore the current situation is acceptable, provided steps are taken to ensure that adverse effect do not extend further. Such steps may include investigations to accurately define the source of the contaminants, the existing level and extent of contamination, and to minimise the future contaminant load of stormwater runoff.

The proposed second round of the GW harbour wide marine sediment quality study and further sediment monitoring proposed by WCC over the next 10 years (see Section 8.2) are intended to meet the further information requirements identified above.

5.5 Effects on marine mammals

The New Zealand fur seal (*Arctocephalus foresteri*) has haul-out areas at Sinclair Head some 3 km west of the Owhiro Bay and seals may occasionally venture into Owhiro Bay or further east. Other marine mammals, in particular the dolphin, are known pass intermittently through this area. However, the known risks associated with stormwater discharges are in sheltered ‘low energy’ areas where particulate material (and associated contaminants) accumulates, potentially affecting the benthic ecology. The South Coast is a high energy environment in which contaminants are rapidly diluted and dispersed and where significant adverse effects on fish, marine mammals or the benthic ecology are unlikely to occur.

5.6 Tangata whenua cultural and spiritual effects

As part of the consultation process for the Moa Point Wastewater Treatment Plant consent applications, tangata whenua organisations contributed to two facilitated workshops and provided comment, through two cultural impact reports, on the proposed discharge of treated wastewater to the south coast and on wet weather overflow discharges.

The key concerns expressed through that process, which are also relevant to the current consent application, relate to the effect of contaminated discharges, including contaminated stormwater discharges, on the mauri of Wellington Harbour and Cook Strait, and on the paua, finfish and rock lobster fisheries in the area.

While wastewater pollution of stormwater has not been eliminated, the marked reduction in indicator bacteria concentrations in stormwater achieved by the SPE programme over the last 15 years (Section 3.3.2) has gone some way towards addressing tangata whenua concerns. WCC is committed to working with relevant tangata whenua during the term of this consent to ensure their views are considered.

5.7 Proposed mitigation

The management of stormwater discharges is supported by a monitoring programme to determine the significance of environmental effects. The programme covers visual, bacteriological, sediment and benthic community monitoring (refer section 8.2). This monitoring is supplemented by observations from staff and members of the public drawing the applicant's attention to obvious visual pollution or activities likely to lead to pollution of stormwater and receiving waters. Responses to instances of stormwater pollution are tailored according to the likely pollution source.

5.7.1 Mitigating the effects of faecal pollution of stormwater

The results of stormwater quality monitoring are analysed to determine if any results require follow up. Over the last fifteen years pollution elimination work has established that an annual dry weather median faecal coliform concentration of 1,000 cfu /100 mls is achievable in Wellington's stormwater discharges. Similarly if an average of three consecutive dry weather samples is over 2,000 faecal coliforms per 100 ml (or an annual median of at least 12 samples exceeds 1000 faecal coliforms per 100ml) an investigation into potential faecal contamination is warranted. The applicant intends that exceedances of the above levels be used to trigger investigations into faecal pollution of stormwater discharges. It is acknowledged that some of this faecal contamination may not be attributable to human sources, but the investigations will be conducted anyway.

If faecal contamination of a stormwater discharge is suspected an investigation is undertaken to determine the source of the pollution. This involves some or all of the following:

- investigation of wastewater and stormwater networks to isolate the source of pollution
- development of options to remove the cause of pollution
- selection and implementation of options to remove pollution
- post implementation monitoring of stormwater quality to determine effectiveness

This process has been successfully used over the last fifteen years to improve water quality as part of the sewage pollution elimination project.

5.7.2 Mitigating the effects of constructed wastewater to stormwater overflows.

Wastewater overflows can occur from weirs or pipes connecting the wastewater and stormwater networks. Such overflows are triggered by blockages, insufficient drain capacity or by periods of heavy or sustained rainfall. Often these overflows were constructed decades ago, to preferentially discharge wastewater to the stormwater network rather than discharge to private property. The rationale behind this was that an overflow to stormwater posed less public health risk than discharges to land. Over the years network improvements have been made that may mean that some of these constructed overflows are no longer required and could potentially be sealed off.

At present there is limited information available on the operation of the constructed overflows. Monitoring is currently underway to determine which of these overflows are operating and to understand the conditions that cause these to operate. Following this, plans to mitigate their operation will be developed. Currently electronic monitoring equipment is installed at fourteen sites with plans to relocate the monitoring equipment to the remaining sites over the next five years. The mitigation plans will consider closure of these overflows or controlling their operation through flow reduction, capacity upgrades, storage or treatment options. Hydraulic and hydrologic models may need to be developed to enable overflow operational characteristics to be understood and mitigation options developed for some of the more complex catchments.

5.7.3 Possible constructed overflow mitigations

Possible constructed overflow mitigation options include:

- Closure where the overflow is no longer required
- Flow reduction – removal of excess wastewater flows causing overflows through implementing inflow and infiltration control programmes.
- Capacity upgrades to enable drains to convey more wastewater.
- Storage where excess wastewater flows are temporarily diverted to storage and later reintroduced to the network after peak flows have subsided.
- Treatment of stormwater to reduce the effects of contaminants present in stormwater before discharge.

5.7.4 Inflow and Infiltration

Excessive inflow[12] and infiltration[13] of stormwater into wastewater drains is the cause of most wet weather overflows from the wastewater network. Some of these overflows result in faecal contamination of stormwater discharges. In December 2008[14] Wellington City Council's Strategy and Policy Committee considered a paper on Inflow and Infiltration (I and I) into private laterals. The committee resolved that options to address inflow and infiltration be further developed for consideration again in March 2009.

The paper noted that $18.2 million of improvement works are earmarked for mitigating the effects of wastewater overflows from the Moa Point and Western wastewater treatment plants over the next 15 years. These overflows are the result of excessive wastewater flows during wet weather attributed to I and I.

The paper also advised the Council that an estimated $70 million of works could be required to mitigate the effects of overflows from constructed overflows over the next 20 years. This figure was provided to Council so they could appreciate the significance of the problem and is based on work presented to the Council in 2007 associated with mitigating the effects of wastewater overflows principally to stormwater networks upstream of the Mount Victoria wastewater tunnel.

Officers of the Council were instructed to develop a detailed policy and implementation plan that incorporates:

1. A cost-benefit analysis of the available options for Wellington city.
2. An analysis of approaches and works undertaken by other Councils.
3. Consideration of amendments to the 2005 Laterals Policy that may be desirable.
4. The timing for the introduction of any implementation.

It should be noted that the cost benefit analysis referred to above will look at social, cultural and environmental benefits of options. It is anticipated that a range of options will be presented for the consideration of the Council involving solutions spanning public and private wastewater networks.

---

[12] Inflow – stormwater entering the wastewater network through gully traps, down pipes and inappropriate connections

[13] Infiltration – stormwater entering wastewater drains through cracks and defects in pipelines and pipe joints

[14] Wellington City Council, Strategy and Policy Committee, Inflow and Infiltration into private wastewater laterals, 11 December 2008.

5.7.5 Mitigating non faecal stormwater contamination.

The applicant's stormwater management practices are detailed in Section 2.3 of this report. There is a limited amount of information available to assess the effects of stormwater on receiving environments arising from non faecal contamination of stormwater. This consent application acknowledges this information deficit and is addressing this with a commitment to a monitoring programme to better assess effects associated with the discharge of non faecal contaminants. Reporting of the results of monitoring is dealt with in Sections 3.3 and 3.4.2.

5.7.6 Land use controls on urban development

The Wellington City Council's "Code Of Practice For Land Development", which controls urban development practices in Wellington City, has been revised. The key changes include encouraging environmentally sustainable stormwater design and strengthened sediment and erosion control. The majority of the changes have been made to the Stormwater and Roading sections. The changes allow alternative solutions and innovation. Where practical alternative approaches to stormwater management including attenuation and/or some disposal on site will be encouraged. This is for the primary purpose of controlling the peak stormwater flow and preventing the further degradation of the water quality and ecology in receiving waters.

Alternative stormwater solutions with the aim of allowing infiltration and filtering to occur will be considered on a case by case basis subject to appropriate site investigations, geotechnical survey; and specific engineering design. The topography, slope, neighbouring properties, etc of the development will be considered in approving the design. The successful implementation of alternative solutions depends on individual circumstances. Each application will be assessed against criteria which include topography and soakage.

5.7.7 Reporting

The applicant will report the results of stormwater monitoring performed under this consent application. Further it will report progress on the development of mitigation plans developed in association with this consent on an annual basis.

5.8 Summary of effects

The conclusions to be drawn from this evaluation of potential effects of discharges of stormwater to Wellington Harbour and the South Coast are that, after reasonably mixing, during the proposed term of the consent the discharges are unlikely cause:

(a) any breach of indicator bacteria guidelines for contact recreation waters or shellfish collection waters;
(b) the production of conspicuous oil or grease films, floatables or suspended material;
(c) any conspicuous change in colour
(d) any significant loss of recreational opportunity; or
(e) any significant impact on aquatic life.

It is also concluded that adverse effects on Maori cultural and spiritual values still exist and it is recognised that there is some uncertainty about the potential effects in the long term (beyond the proposed term of this consent) of contaminated stormwater discharges on the benthic ecology of Wellington Harbour. For that reason, an increased level of monitoring is proposed, including monitoring of marine sediment quality and the benthic ecology and a limited duration of 10 years is proposed.

6 Proposed monitoring programme

Wellington City Council commissioned MWH (2008) to review its routine stormwater monitoring programme with the aim of meeting the information requirements of this consent application. The study concluded that there is scope to rationalise some of the coastal water monitoring undertaken by Council, that a sharper focus on stormwater monitoring could be provided, and that a greater emphasis should be placed on monitoring marine sediments and benthic biota in the vicinity of major stormwater outfalls.

It is anticipated that the recommendations of that report will form the basis of a monitoring programme to be incorporated into the new consent (refer Section 10.2 for suggested consent conditions).

7 Consultation

Informal discussions have been held with Wellington Regional Council, Department of Conservation, Regional Public Health, Wellington Tenths Trust and Ngati Toa as well as the Royal Forest and Bird Protection Society of New Zealand, South Coast Marine Reserve Coalition (now defunct with the formal creation of the reserve) and the Environmental Reference Group (ERG).

The key stakeholders were informally presented with the concept of a single consent that would cover the stormwater discharges into the Wellington coastal marine environs with the intention of initiating a monitoring programme focused on the receiving areas rather than purely on stormwater quality. With continued sampling for microbiological contaminants providing for the public health protection requirements and sediment and benthic sampling to provide for a greater understanding of the effects of stormwater on the ecology the position of the Council was shown to be providing for a more strategic and holistic approach to stormwater management.

Responses from the various parties have all been in support of a holistic approach that sets the scene for more information about the effects of stormwater being made available. This was tempered slightly with questions of what mitigation efforts might follow a monitoring programme and how stormwater contaminants might also be addressed. Overall however it was seen as a logical and pragmatic manner to approach the management of stormwater discharges.

Iwi also spoke of an interest in the inclusion of cultural measures alongside the more scientific indicators. This work is very much in its infancy when coastal marine areas are considered. While there has been work completed by the Ministry for the Environment on cultural health indices for freshwater waterways there appears to be only a few components that could be transferred to the coastal marine environment.

Discussions centered around the effects of a monitoring programme are planned to continue beyond the application being lodged and will cover areas such as mitigation, education programmes and addressing the sources of stormwater contamination in a fashion that provides for sustainable solutions that are both fiscally responsible and performance driven.

8 Conclusions and suggested consent conditions

8.1 General conclusions

The current proposal is for the consolidation of existing consents and the formalising of other existing stormwater discharges (which may from time to time not meet the permitted activity criteria). There will be no additional effects, as the discharges already exist. Wellington City's stormwater network is an essential infrastructure service conveying stormwater away from the urban environment.

The effects of stormwater discharges from the City to the CMA have been outlined and evaluated. The information available from monitoring and special investigations indicates that discharges of stormwater to Wellington Harbour and the South Coast have the potential to affect water quality at bathing beaches, and to temporarily increase the health risks for bathers and those engaged in other contact recreational activities at such times, but are unlikely to cause the *Contact Recreation* or *Shellfish Gathering* water quality criteria in the RCP to be exceeded.

The risks to public health are appropriately mitigated by the WCC's ongoing efforts to detect and correct reticulation faults and by the GWRC/WCC bathing beach monitoring programme, which includes a management response to address health risks, and which may from time to time result in the erection of public health warning signs at bathing beaches.

Stormwater discharges are unlikely to result in toxicity to aquatic life within the water column, but have been shown to cause elevated contaminant levels in marine sediments in sheltered parts of Wellington Harbour. On existing information it is not possible to determine if marine sediment concentrations of metals or persistent organic contaminants are likely to increase with the continuation of these stormwater discharges, or whether adverse effects on the marine ecology are likely to occur in the long term, beyond a reasonable mixing zone.

Further monitoring is required to properly characterise that risk. Hence WCC has sought a consent of 10-year duration, and has proposed a significantly enhanced stormwater quality, marine sediment and benthic ecology monitoring programme to be undertaken over that period. At this stage, there are no obvious effects that are significant, that would prevent the granting of a 10-year consent.

8.2 Suggested consent conditions

This section sets out the consent conditions that the applicant envisages being placed on the consent to formalise the undertaking to avoid, remedy or mitigate adverse effects.

1. The location and operation of the stormwater discharges shall be in general accordance with the consent application and its associated plans and documents lodged with the Wellington Regional Council on xx December 2008.

2. On at least twelve occasions each year, at approximately monthly intervals, the permit holder shall collect representative samples of the stormwater from:
   - (i) Owhiro Stream (B22-017)
   - (ii) Island Bay Culvert (C26070)
   - (iii) Houghton Bay Culvert (C31040)
   - (iv) Lyall Bay East Culvert (F34-014)
   - (v) Lyall Bay West Culvert (G37-050)
   - (vi) Hataitai Culvert, Evans Bay (K35-037)*

(vii) Miramar Culvert, Evans Bay (J40-010)*

(viii) Kilbirnie Culvert, Evans Bay *

(ix) Cobham Culvert, Evans Bay (J37-001)*

(x) Overseas Passenger Culvert (Q32035)*

(xi) Tory Street Culvert (Q30-026)*

(xii) Taranaki Street Culvert (Q30-017)*

(xiii) Te Aro Culvert (Q29-110)*

(xiv) Harris Street Culvert (R29-110)*

(xv) Waring Taylor Culvert (S29079)*

(xvi) Bowen Street Culvert (S29-091)*

(xvii) Davis Street Culvert (V32-022)*

(xviii) Thorndon Quay Culvert (W31-010)*

(xix) Kaiwharawhara Stream (Y33-052)

(xx) Ngauranga Stream (AC41-016)

At those sites potentially affected by tidal influence*, the samples shall be collected at mid to low tide. All samples shall be analysed for:

- *Enterococci*
- Faecal coliforms
- *E. coli*

Rainfall (mm) shall be recorded for each site on each sampling occasion from the nearest suitable rain gauge for the 24 hour period prior to sample collection.

3. On two occasions each year (once in the period January to June and once in the period July to December) the permit holder shall collect representative samples of the stormwater from:

(i) Island Bay Culvert (C26070)

(ii) Houghton Bay Culvert (C31040)

(iii) Miramar Culvert (J40010)

(iv) Cobham Culvert (J37001)

(v) Overseas Passenger Culvert (Q32035) and

(vi) Waring Taylor Culvert (S29079).

These samples shall be collected during a wet weather event (at a time when at least 6 mm of rain has fallen within the preceding 12 hour period), at mid to low tide, and analysed for:

- total suspended solids,
- total Kjeldahl nitrogen,
- total phosphorus,
- pH,
- total metals (As, Cd, Cr, Cu, Pb, Ni and Zn),
- dissolved metals (As, Cd, Cr, Cu, Pb, Ni and Zn) and

- Polycyclic aromatic hydrocarbons

4. On three occasions during the term of this consent (year one, five and nine) the permit holder shall undertake a marine sediment monitoring programme around the following stormwater outfalls:

   (i) Island Bay Culvert (C26070)

   (ii) Cobham Culvert (J37001)

   (iii) Overseas Passenger Culvert (Q32035) and

   (iv) Waring Taylor Culvert (S29079).

   At each outfall location three sampling sites are to be located on each of two transects radiating out from the outfall at an angle of 45 degrees (six sites per outfall). These sampling sites shall be located at approximately 15m, 50m and 150m from the outfall. Five random sediment core samples taken at each site shall be combined to form a single composite sample per site. Each composite sample shall be analysed for:

   - particle size distribution,
   - TOC,
   - total metals (As, Cd, Cr, Cu, Hg, Pb, Ni and Zn)
   - weak acid extractable metals (As, Cd, Cr, Cu, Hg, Pb, Ni and Zn),
   - PAHs

5. On two occasions during the term of this consent (years one and nine) the permit holder shall undertake a marine benthos monitoring programme around the following stormwater outfalls:

   (i) Island Bay Culvert (C26070)

   (ii) Cobham Culvert (J37001)

   (iii) Overseas Passenger Culvert (Q32035) and

   (iv) Waring Taylor Culvert (S29079).

   At each outfall location three sampling sites shall be established along a transects running offshore from each outfall, roughly perpendicular to the shoreline. At each site the centre of the proposed collection area, being circle of 5m radius, shall be located at approximately 15m, 50m, and 150m from the outfall. Three deep sediment cores shall be collected at each collection area and sorted. The benthic fauna in each of the replicate samples shall be Identified and counted.

6. All sampling techniques employed in respect of the conditions of this permit shall be acceptable to the Manager, Environmental Regulation, Wellington Regional Council. All analyses shall be performed by an International Accreditation New Zealand (IANZ) laboratory or otherwise to the satisfaction of the Manager, Environmental Regulation, Wellington Regional Council.

7. During each sampling event the permit holder shall visually inspect the discharge and immediate receiving waters around the point of discharge for the following:

   (a) Any conspicuous oil or grease films, scums or foams, or floatable or suspended materials

   (b) Any conspicuous change in colour or visual clarity;

(c) Any undesirable biological growths;

(d) Any emission of objectionable odour; and

(e) Any erosion at the point of discharge.

8. The results of the sampling required by conditions 2, 3, 4 and 5 of this permit shall be forwarded in written and electronic format to the Manager, Environmental Regulation, Wellington Regional Council, by the 1st August each year. The written copies of the results for conditions 2, 3 and 4 shall be in the form of analytical certificates under the letterhead of the laboratory which carried out the analyses and bear the authorised signatures.

The results shall include the sample dates and times in New Zealand Standard time.

9. The results of sampling required by conditions 2, 3, 4 and 5 of this permit shall be reported to the Manager, Environmental Regulation, Wellington Regional Council, in writing by 1 August each year in an annual report. The report shall be to the satisfaction of the Manager, Environmental Regulation, Wellington Regional Council, and shall include, but not be limited to the following:

(a) Details of daily rainfall (mm) from the closest relevant rain gauge to each of the stormwater sampling sites in the 10 days preceding each sampling event.

(b) Calculations of the predicted stormwater discharge rate at the time of sampling

(c) Laboratory analytical certificates for the stormwater and sediment samples.

(d) Observations and photographs from the visual inspections undertaken under condition 7 of this consent.

(e) Any other matters the permit holder considers relevant.

10. The permit holder shall undertake sanitary surveys should the annual median result (for the year July to June) from monitoring of faecal coliforms under condition 2 of this permit exceeds 1,000 cfu/100ml, *or* if the average of three consecutive dry weather samples exceeds 2,000 cfu/100ml.

Note: A sanitary survey includes an initial comparison of the results to previous stormwater sampling results, follow-up sampling if required; visual inspection of the discharge including lifting of man hole covers; and closed circuit television monitoring if required.

The sanitary survey shall be followed by development of remedial works options and implementation of remedial works targeted to overcome the causes of faecal contamination identified in the sanitary survey.

The outcomes of any sanitary surveys undertaken shall be detailed in the annual report as required by condition 9 of this permit.

The investigations and follow up works undertaken shall be to the satisfaction of the Manager, Environmental Regulation, Wellington Regional Council.

11. The permit holder shall place and maintain appropriate signage around the stormwater outfalls scheduled in Table 2.1 to the satisfaction of the Manager, Environmental Regulation, Wellington Regional Council. The sign shall:

(a) Provide clear identification of the location and nature of the discharge and the risk to public health from bathing, and the collection and consumption of shellfish within the vicinity of the discharge;

(b) Be visible to the public visiting the area without unnecessarily detracting from the visual amenity of the areas; and

(c) Contain appropriate wording to the approval of the Manager, Environmental Regulation, Wellington Regional Council. Regional Public Health shall be consulted about the wording of signs.

12. The permit holder shall undertake monitoring of wastewater to stormwater constructed overflows over the next five years. Plans to mitigate the effects of these overflows shall be developed that will consider options such as:

(a) closure where the overflow is no longer required,

(b) flow reduction – removal of excess wastewater flows causing overflows through implementing inflow and infiltration control programmes,

(c) capacity upgrades to enable drains to convey more wastewater,

(d) storage where excess wastewater flows are temporarily diverted to storage and later reintroduced to the network after peak flows have subsided,

(e) treatment of stormwater to reduce the effects of contaminants present in stormwater before discharge.

Results of the constructed overflow monitoring and progress on the development of these plans shall be reported annually to the Manager, Environmental Regulation, Wellington Regional Council.

13. The Wellington Regional Council may review any or all conditions of this permit by giving notice of its intention to do so pursuant to section 128 of the Resource Management Act 1991, at any time within three months of the 30 June each year for the duration of this permit, for any of the following purposes:

(a) To deal with any adverse effects on the environment which may arise from the exercise of the permit and which it is appropriate to deal with at a later stage; or

(b) To review the adequacy of any monitoring plans and/or alter any monitoring requirements so as to incorporate into the permit any monitoring or other requirements which may become necessary to clarify or deal with any adverse effect on the environment of arising from this activity.

14. The Wellington Regional Council shall be entitled to recover from the permit holder the actual and reasonable costs of the conduct of any review, calculated in accordance with and limited to the Council's scale of charges in-force and applicable at that time pursuant to Section 36 of the Resource Management Act 1991.

REFERENCES

Ahrens, M; Olsen, G. (2007). *Analysis of Evans Bay Sediments.* A NIWA Consultancy Report prepared for Wellington City Council.

ANZECC (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Environment and Conservation Council.

Auckland Regional Council (2004). *Blueprint for monitoring urban receiving environments*. ARC Technical Publication 168 revised edition.

Bolton-Ritchie L. (1999). Progress report – July 1999. *The effect of stormwater effluent on the ecology of the shallow soft bottom benthos of inner Wellington Harbour*. Prepared for Wellington City Council. 2pp.

Bolton-Ritchie L.; Chague-Goff, C.; Gardner, J.; Goff, .(1999a). *Wellington storm drain sediments – spreading it around*. Abstract. Proceedings of the New Zealand Water and Wastes Association Conference, September 22nd-24th, Christchurch, 137-144.

Bolton-Ritchie L.; Chague-Goff, C.; Gardner, J.; Goff, .(1999b). *A preliminary investigation into the effect of point source stormwater discharge on the marine benthic environment of inner Wellington Harbour*. Abstract. Proceedings of the Comprehensive Stormwater & Aquatic Ecosystems conference, 1999.

Bolton-Ritchie L (2003). *The effects of stormwater discharge on the nearshore benthic environment of inner Wellington Harbour* (PhD Thesis submitted to the Victoria University of Wellington)

Capacity (2007). *Stormwater discharge consent renewal data analysis. Internal report*

Dickinson WW, Dunbar GB and McLeod H, (1996). *Heavy metal history from cores in Wellington Harbour, New Zealand. Environmental Geology 27: 59-69.*

Greater Wellington Regional Council (2008). *Wellington Harbour marine sediment quality investigation*. Report prepared by G. Stephenson (Coastal Marine Ecology Consultants), J.R. Milne and P. Sorenson (Environmental Monitoring and Investigations Department, Greater Wellington Regional Council) in association with Wellington City Council and Hutt City Council.

Greater Wellington Regional Council (2008a). *Annual recreational water quality monitoring report for the Wellington Region.*

Heath, R.A. (1997). *Circulation and Hydrology of Wellington Harbour.* New Zealand Oceanographic Summary No. 12, 8pp.

Kennedy, P. (2003). *The effects of road transport on freshwater and marine ecosystems.* Ministry of Transport, Wellington, New Zealand. 142pp.

Kingett Mitchell Ltd (2005). *Assessment of urban stormwater quality in the Greater Wellington Region.* Report prepared for Greater Wellington Regional Council.

Ministry for the Environment, (2003): *Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas.* Wellington, NZ.

MWH NZ Ltd (2003). *Baseline Assessment of Environmental Effects of Contaminated urban stormwater discharges into Wellington Harbour and the South Coast.* A report prepared for Wellington City Council.

MWH NZ Ltd (2008). *Monitoring of stormwater discharges from Wellington City to Wellington Harbour and the South Coast*. A report prepared for Wellington City Council.

Pilloto PJ, (1996). *Metal Pollution in Wellington Harbour*. MSc thesis, Chemistry Dept, Victoria University of Wellington

Pilloto PJ, Goff JR, Weatherburn DC, (1998). *A contemporary contamination record of stormdrain and harbour sediments, Wellington, New Zealand.*

Stephenson, G. (2007). *Investigations of marine sediment quality in the vicinity of the stormwater outfall at Miramar Wharf: Benthic ecology.* A report prepared for the Wellington City Council.

Stoffers P, Glasby GP, Wilson CJ, Davis KR, Walter P, (1986). *Heavy metal pollution in Wellington Harbour. New Zealand of Marine and Freshwater Research, 1986, Vol 20: 495-512.*

Timperley M., Bailey, G., Pattinson, P. & Kushel, G. (2003). *Zinc, copper and lead in road run-off.* Paper presented at the 26th Australasian Transport Research Forum, Wellington.

Wear, R.G.; Haddon, M. (1992). *Summary of marine ecological and environmental studies in Wellington Harbour and Environs*. Victoria University of Wellington Coastal Maine Research Unit Report No. 17.

Williamson R.B, Goff J, Ray D, Mills G, and Berkenbusch, K. (2001). *Effects of urban stormwater in the Wellington Region: A synthesis of the existing information.* Report prepared for Wellington Regional Council.

Appendix I: Existing resource consents

Appendix II: Location of major stormwater discharges

Appendix III: Wellington Harbour Marine Sediment Quality Summary Results (GWRC 2008)

The following (Figure 1.1, Table 4.1 and Table 4.2) are reproduced, with permission, from:

> Greater Wellington Regional Council (2008). *Wellington Harbour marine sediment quality investigation*. Report prepared by G. Stephenson (Coastal Marine Ecology Consultants), J.R. Milne and P. Sorenson (Environmental Monitoring and Investigations Department, Greater Wellington Regional Council) in association with Wellington City Council and Hutt City Council.

The reader is referred to the full report for a description of the methods employed, guidelines used, and a comprehensive analysis of results.

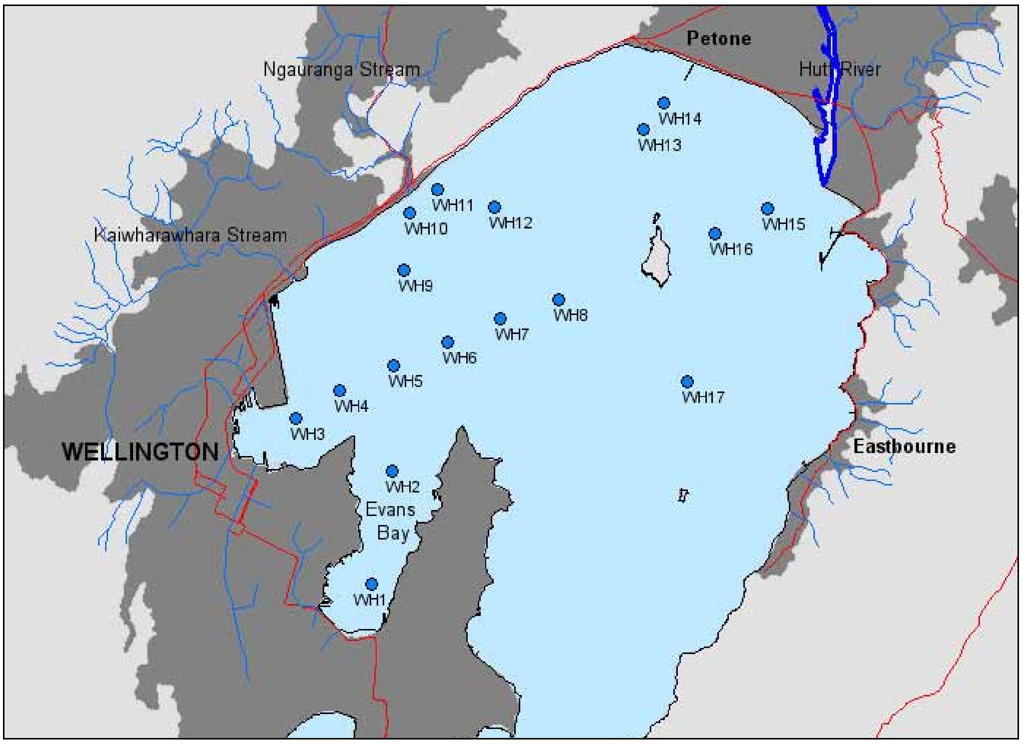

Figure 1.1: Map of Wellington Harbour showing the 17 subtidal locations sampled in 2006 for the Wellington Harbour marine sediment quality investigation.

Table 4.1: Mean particle size, percentage of particles < 63 µm, and summary of concentrations and variability (coefficient of variation [c.v., %], n = 5) of metals, dibutyltin (DBT) and tributyltin (TBT) in sediments of 17 sites sampled in Wellington Harbour in 2006. Sediment quality guidelines for comparison are ANZECC (2000) and Auckland Regional Council Environmental Response Criteria (ARC ERC; ARC 2004). Values in amber exceed the ARC ERC amber threshold and values in red exceed the ARC ERC red threshold and/or ANZECC ISQG-Low.

Analyte	Fraction	ANZECC		ARC ERC		WH1		WH2		WH3		WH4		WH5	
	analysed	ISQG-Low	ISQG-High	amber	red	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.
Mean particle size (µm)	< 500 µm					94.02	3.5	60.31	18.7	59.31	21.3	43.25	20.2	35.27	15.3
% particles < 63 µm	< 500 µm					25.52	10.3	57.85	13.0	58.19	19.7	72.88	14.2	85.00	8.2
Metals (mg/kg, 2 M HCl):															
Copper	< 63 µm					20.8	7.9	14.2	5.9	25.0	6.3	14.4	6.2	9.8	8.5
Lead	< 63 µm					69.0	7.9	50.5	6.7	60.4	4.8	44.5	4.7	34.3	5.9
Zinc	< 63 µm					121.6	5.3	101.2	6.4	116.6	4.9	93.2	4.8	75.8	5.1
Metals (mg/kg, total digest):															
Silver	< 500 µm	1	3.7			0.7		0.5		0.6		0.4		<0.4	
Arsenic	< 500 µm	20	70			6.2		5.0		6.1		6.1		6.3	
Cadmium	< 500 µm	1.5	10			0.08		0.05		0.06		0.06		0.05	
Chromium	< 500 µm	80	370			23.7		24.5		25.6		24.9		24.4	
Copper	< 500 µm	65	270	19	34	25.7		19.2		31.6		20.2		16.9	
Mercury	< 500 µm	0.15	1			0.79		0.62		0.77		0.51		0.32	
Nickel	< 500 µm	21	52			16.6		17.6		18.2		17.3		18.4	
Lead	< 500 µm	50	220	30	50	67.1		51		62.5		50.5		37.9	
Antimony	< 500 µm					<0.4		<0.4		<0.4		<0.4		<0.4	
Zinc	< 500 µm	200	410	124	150	130		114		132		117		99.1	
Organotins (µg Sn/kg):															
Dibutyltin	< 500 µm					12		10		22		17		12	
Tributyltin	< 500 µm	5	70			< 5		< 3		9		6		< 3	

Table 4.1 *continued*: Mean particle size, percentage of particles < 63 µm, and summary of concentrations and variability (coefficient of variation [c.v., %], n = 5) of metals, dibutyltin (DBT) and tributyltin (TBT) in sediments of 17 sites sampled in Wellington Harbour in 2006. Sediment quality guidelines for comparison are ANZECC (2000) and Auckland Regional Council Environmental Response Criteria (ARC ERC; ARC 2004). Values in amber exceed the ARC ERC amber threshold and values in red exceed the ARC ERC red threshold and/or ANZECC ISQG-Low.

Analyte	Fraction	ANZECC		ARC ERC		WH6		WH7		WH8		WH9		WH10	
	analysed	ISQG-Low	ISQG-High	amber	red	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.
Mean particle size (µm)	< 500 µm					34.36	4.3	37.55	6.6	36.96	6.7	27.83	8.3	23.06	19.6
% particles < 63 µm	< 500 µm					87.53	2.3	85.13	3.5	84.90	3.6	93.18	3.9	95.17	6.7
<u>Metals (mg/kg, 2 M HCl):</u>															
Copper	< 63 µm					8.8	5.1	8.8	5.1	9.4	5.8	10.8	4.1	12.6	4.3
Lead	< 63 µm					32.4	5.0	32.0	4.8	33.9	5.3	40.1	2.5	45.8	2.1
Zinc	< 63 µm					70.8	4.2	73.0	5.2	76.2	3.9	85.4	2.7	92.8	2.1
<u>Metals (mg/kg, total digest):</u>															
Silver	< 500 µm	1	3.7			<0.4		<0.4		<0.4		<0.4		<0.4	
Arsenic	< 500 µm	20	70			6.7		6.0		6.8		6.3		6.9	
Cadmium	< 500 µm	1.5	10			0.05		0.04		0.04		0.05		0.05	
Chromium	< 500 µm	80	370			23.5		22.8		24.1		25.2		25.9	
Copper	< 500 µm	65	270	19	34	14.2		13.2		15.0		15.7		17.9	
Mercury	< 500 µm	0.15	1			0.25		0.21		0.19		0.29		0.36	
Nickel	< 500 µm	21	52			17.5		17.2		18.8		18.7		18.2	
Lead	< 500 µm	50	220	30	50	35.3		30.3		32.3		40.2		48.1	
Antimony	< 500 µm					<0.4		<0.4		<0.4		<0.4		<0.4	
Zinc	< 500 µm	200	410	124	150	96.3		88.3		93.6		103		113	
<u>Organotins (µg Sn/kg):</u>															
Dibutyltin	< 500 µm					12		11		14		16		12	
Tributyltin	< 500 µm	5	70			< 3		< 3		< 3		< 5		< 3	

Table 4.1 *continued*: Mean particle size, percentage of particles < 63 µm, and summary of concentrations and variability (coefficient of variation [c.v., %], n = 5) of metals, dibutyltin (DBT) and tributyltin (TBT) in sediments of 17 sites sampled in Wellington Harbour in 2006. Sediment quality guidelines for comparison are ANZECC (2000) and Auckland Regional Council Environmental Response Criteria (ARC ERC; ARC 2004). Values in amber exceed the ARC ERC amber threshold and values in red exceed the ARC ERC red threshold and/or ANZECC ISQG-Low.

Analyte	Fraction	ANZECC		ARC ERC		WH11		WH12		WH13		WH14		WH15	
	analysed	ISQG-Low	ISQG-High	amber	red	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.
Mean particle size (µm)	< 500 µm					24.75	32.0	27.99	18.0	27.57	6.1	34.00	4.0	50.06	6.7
% particles < 63 µm	< 500 µm					94.13	7.4	91.74	7.1	94.84	1.2	88.04	1.3	66.70	8.9
<u>Metals (mg/kg, 2 M HCl):</u>															
Copper	< 63 µm					13.2	3.4	11.2	4.0	13.6	6.6	15.6	3.5	13.4	4.1
Lead	< 63 µm					48.8	2.0	42.7	3.5	40.5	6.0	38.9	1.5	27.7	2.9
Zinc	< 63 µm					96.8	1.3	86.2	2.2	97.0	6.6	95.6	2.5	74.4	2.4
<u>Metals (mg/kg, total digest):</u>															
Silver	< 500 µm	1	3.7			<0.4		<0.4		<0.4		<0.4		<0.4	
Arsenic	< 500 µm	20	70			7.3		6.7		7.9		8.6		8.0	
Cadmium	< 500 µm	1.5	10			0.06		0.04		0.06		0.09		0.07	
Chromium	< 500 µm	80	370			26.1		25.4		25.7		21.7		18.3	
Copper	< 500 µm	65	270	19	34	18.6		16.0		18.4		18.3		15.4	
Mercury	< 500 µm	0.15	1			0.33		0.24		0.23		0.21		0.15	
Nickel	< 500 µm	21	52			18.5		18.3		19.7		16.1		15.1	
Lead	< 500 µm	50	220	30	50	50.5		40.1		40.2		38.2		24.9	
Antimony	< 500 µm					<0.4		<0.4		<0.4		<0.4		<0.4	
Zinc	< 500 µm	200	410	124	150	119		106		112		107		84.5	
<u>Organotins (µg Sn/kg):</u>															
Dibutyltin	< 500 µm					14		12		9		12		10	
Tributyltin	< 500 µm	5	70			< 5		12		< 3		< 5		< 3	

Table 4.1 *continued*: Mean particle size, percentage of particles < 63 µm, and summary of concentrations and variability (coefficient of variation [c.v., %], n = 5) of metals, dibutyltin (DBT) and tributyltin (TBT) in sediments of 17 sites sampled in Wellington Harbour in 2006. Sediment quality guidelines for comparison are ANZECC (2000) and Auckland Regional Council Environmental Response Criteria (ARC ERC; ARC 2004). Values in amber exceed the ARC ERC amber threshold and values in red exceed the ARC ERC red threshold and/or ANZECC ISQG-Low.

Analyte	Fraction	ANZECC		ARC ERC		WH16		WH17	
	analysed	ISQG-Low	ISQG-High	amber	red	mean	c.v.	mean	c.v.
Mean particle size (µm)	< 500 µm					41.88	15.1	74.17	12.3
% particles < 63 µm	< 500 µm					75.24	14.3	38.27	26.3
Metals (mg/kg, 2 M HCl):									
Copper	< 63 µm					11.2	7.5	9.8	4.6
Lead	< 63 µm					34.4	4.8	33.1	3.2
Zinc	< 63 µm					84.4	3.2	80.2	2.4
Metals (mg/kg, total digest):									
Silver	< 500 µm	1	3.7			<0.4		<0.4	
Arsenic	< 500 µm	20	70			7.0		6.2	
Cadmium	< 500 µm	1.5	10			0.05		0.03	
Chromium	< 500 µm	80	370			23.4		20.7	
Copper	< 500 µm	65	270	19	34	15.0		11.9	
Mercury	< 500 µm	0.15	1			0.19		0.16	
Nickel	< 500 µm	21	52			18.3		15.8	
Lead	< 500 µm	50	220	30	50	34.1		30	
Antimony	< 500 µm					<0.4		0.5	
Zinc	< 500 µm	200	410	124	150	97.7		83.9	
Organotins (µg Sn/kg):									
Dibutyltin	< 500 µm					23		9	
Tributyltin	< 500 µm	5	70			< 3		< 3	

Table 4.2: Summary of concentrations and variability (coefficient of variation [cv, %], n = 5) of total organic carbon (TOC) and selected organic contaminants in sediments of 17 sites sampled in Wellington Harbour in 2006. Sediment quality guidelines for comparison are ANZECC (2000) and Auckland Regional Council Environmental Response Criteria (ARC ERC; ARC 2004). Values in amber exceed the ANZECC ISQG-Low or ARC ERC amber threshold and values in red exceed the ANZECC ISQG-Low and ARC ERC red threshold.

Analyte	Fraction	ANZECC		ARC ERC		WH1		WH2		WH3		WH4		WH5	
	analysed	ISQG-Low	ISQG-High	amber	red	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.
TOC (%)	< 500 µm					1.72	1.7	1.43	2.0	1.78	1.6	1.59	1.0	1.38	0.6
Organics (µg/kg):															
Fluorene	< 500 µm					42.8	9.3	14.4	7.9	27.6	7.1	13.6	6.6	6.9	6.8
Phenanthrene	< 500 µm					428	11.0	160	6.3	348	4.7	158	8.3	71	6.1
Benzo(a)anthracene	< 500 µm					538	7.2	190	3.7	348	4.3	170	4.2	78.2	8.7
Total PAH[1,2]	< 500 µm					6,414	6.1	2,452	2.5	4,588	3.0	2,302	4.6	1,097	4.6
Total HMW PAH[1,2]	< 500 µm					3,585	6.5	1,368	2.3	2,601	3.4	1,279	5.2	593	5.7
Hexachlorobenzene	< 500 µm					< 0.2		< 0.2		0.6	52.0	< 0.2		< 0.2	
Total DDT[2,3]	< 500 µm					12.7	18.3	4.9	23.9	14.2	35.4	5.6	12.7	3.5	40.5
Fluorene	at 1% TOC[4]	19	540			25	8.3	10	9.0	16	7.1	9	7.2	5	6.5
Phenanthrene	at 1% TOC	240	1500			248	10.0	112	6.6	196	5.8	99	8.8	51.3	5.7
Benzo(a)anthracene	at 1% TOC	261	1600			312	7.9	133	3.8	196	3.8	107	5.1	56.5	8.3
Total PAH	at 1% TOC	4000	45000			3,722	6.5	1,715	3.5	2,580	3.1	1,445	5.3	793	4.2
Total HMW PAH	at 1% TOC	1700	9600	660	1700	2,081	7.0	957	3.4	1,463	3.3	803	5.9	429	5.3
Hexachlorobenzene	at 1% TOC					< 0.2		< 0.2		0.4	39.5	< 0.2		< 0.2	
Total DDT	at 1% TOC	1.6	46		3.9	7.4	18.6	3.4	22.5	8.0	35.1	3.5	11.7	2.5	40.8

1 Polycyclic aromatic hydrocarbons have been summarised as "Total PAH" (all the PAH compounds analysed), and as "Total High Molecular Weight PAH", which is the sum of the concentrations of chrysene, fluoranthene, pyrene, benzo[a]anthracene, benzo[a]pyrene, and dibenzo[a,h]anthracene. This is the total used for the ANZECC (2000) sediment quality guidelines and ARC ERC (ARC 2004). All the PAH compounds analysed are listed in Appendix 2.

2 For the purpose of calculating Total PAH, Total HMW PAH, and Total DDT, the concentration of any individual compound reported at "less than detection limit" has been replaced by a value one half of the detection limit.

3 DDT and related compounds have been summarised as "Total DDT", which is the sum of the concentrations of 2,4'-DDE, 2,4'-DDD, 2,4'-DDT, 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT.

4 This TOC "normalisation" is used in the ANZECC sediment quality guidelines and ARC ERC for comparing sediments with different TOC content.

Table 4.2 *continued*: Summary of concentrations and variability (coefficient of variation [cv, %], n = 5) of total organic carbon (TOC) and selected organic contaminants in sediments of 17 sites sampled in Wellington Harbour in 2006. Sediment quality guidelines for comparison are ANZECC (2000) and Auckland Regional Council Environmental Response Criteria (ARC ERC; ARC 2004). Values in amber exceed the ANZECC ISQG-Low or ARC ERC amber threshold and values in red exceed the ANZECC ISQG-Low and ARC ERC red threshold.

Analyte	Fraction	ANZECC		ARC ERC		WH6		WH7		WH8		WH9		WH10	
	analysed	ISQG-Low	ISQG-High	amber	red	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.
TOC (%)	< 500 µm					1.38	0.6	1.31	2.4	1.36	1.9	1.50	1.5	1.67	1.2
Organics (µg/kg):															
Fluorene	< 500 µm					5.5	3.4	4.8	4.9	4.72	6.6	6.92	8.8	8.64	6.6
Phenanthrene	< 500 µm					47.4	3.2	38.6	6.0	35.8	5.4	65.4	15.8	88.6	5.3
Benzo(a)anthracene	< 500 µm					48.6	4.7	37.6	4.0	36.4	4.6	65.6	9.6	99.2	8.6
Total PAH[1,2]	< 500 µm					736	3.8	585	2.8	567	4.4	993	9.2	1354	2.4
Total HMW PAH[1,2]	< 500 µm					384	4.5	301	9.6	289	4.5	526	10.7	729	2.7
Hexachlorobenzene	< 500 µm					< 0.2		< 0.2		< 0.2		< 0.2		< 0.2	
Total DDT[2,3]	< 500 µm					3.2	19.1	2.9	12.8	2.4	15.8	3.0	8.0	3.6	9.4
Fluorene	at 1% TOC[4]	19	540			4	3.4	4	6.2	3	6.7	5	8.0	5	6.3
Phenanthrene	at 1% TOC	240	1,500			34	3.0	30	7.2	26	5.0	43	15.2	53	5.6
Benzo(a)anthracene	at 1% TOC	261	1,600			35	5.1	29	5.1	27	4.1	44	8.7	59	9.1
Total PAH	at 1% TOC	4,000	45,000			533	4.0	448	4.7	417	4.6	660	8.4	809	3.4
Total HMW PAH	at 1% TOC	1,700	9,600	660	1,700	278	4.7	230	5.1	213	4.4	350	9.8	435	3.5
Hexachlorobenzene	at 1% TOC					< 0.2		< 0.2		< 0.2		< 0.2		< 0.2	
Total DDT	at 1% TOC	1.6	46		3.9	2.3	19.1	2.2	12.6	1.8	14.9	2.0	7.5	2.1	9.4

[1] Polycyclic aromatic hydrocarbons have been summarised as "Total PAH" (all the PAH compounds analysed), and as "Total High Molecular Weight PAH", which is the sum of the concentrations of chrysene, fluoranthene, pyrene, benzo[a]anthracene, benzo[a]pyrene, and dibenzo[a,h]anthracene. This is the total used for the ANZECC (2000) sediment quality guidelines and ARC ERC (ARC 2004). All the PAH compounds analysed are listed in Appendix 2.

[2] For the purpose of calculating Total PAH, Total HMW PAH, and Total DDT, the concentration of any individual compound reported at "less than detection limit" has been replaced by a value one half of the detection limit.

[3] DDT and related compounds have been summarised as "Total DDT", which is the sum of the concentrations of 2,4'-DDE, 2,4'-DDD, 2,4'-DDT, 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT.

[4] This TOC "normalisation" is used in the ANZECC sediment quality guidelines and ARC ERC for comparing sediments with different TOC content.

Table 4.2 *continued*: Summary of concentrations and variability (coefficient of variation [cv, %], n = 5) of total organic carbon (TOC) and selected organic contaminants in sediments of 17 sites sampled in Wellington Harbour in 2006. Sediment quality guidelines for comparison are ANZECC (2000) and Auckland Regional Council Environmental Response Criteria (ARC ERC; ARC 2004). Values in amber exceed the ANZECC ISQG-Low or ARC ERC amber threshold and values in red exceed the ANZECC ISQG-Low and ARC ERC red threshold.

Analyte	Fraction	ANZECC		ARC ERC		WH11		WH12		WH13		WH14		WH15	
	analysed	ISQG-Low	ISQG-High	amber	red	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.	mean	c.v.
TOC (%)	< 500 µm					1.72	0.5	1.61	0.6	1.83	0.5	2.16	1.3	2.17	1.2
Organics (µg/kg):															
Fluorene	< 500 µm					8.68	5.4	5.6	3.6	5.92	3.2	6.74	6.7	5.14	5.6
Phenanthrene	< 500 µm					90	7.2	54	2.9	51.2	2.9	56.8	7.0	34.6	3.3
Benzo(a)anthracene	< 500 µm					104.4	7.8	61	2.8	55	8.7	49.8	3.9	23.4	11.1
Total PAH[1,2]	< 500 µm					1,338	3.7	787	0.4	712	3.9	655	3.6	364	5.0
Total HMW PAH[1,2]	< 500 µm					726	5.6	421	1.0	381	4.0	358	3.8	186	7.1
Hexachlorobenzene	< 500 µm					< 0.2		< 0.2		< 0.2		< 0.2		< 0.2	
Total DDT[2,3]	< 500 µm					4.0	11.5	2.8	17.3	3.3	4.3	5.1	18.5	3.8	9.1
Fluorene	at 1% TOC[4]	19	540			5	5.4	3	3.2	3	3.3	3	7.8	2	6.1
Phenanthrene	at 1% TOC	240	1,500			52	7.3	34	3.0	28	2.7	26	8.1	16	3.2
Benzo(a)anthracene	at 1% TOC	261	1,600			61	7.6	38	2.3	30	8.6	23	5.2	11	11.0
Total PAH	at 1% TOC	4,000	45,000			777	3.5	490	0.7	389	3.8	303	4.9	168	4.8
Total HMW PAH	at 1% TOC	1,700	9,600	660	1,700	421	5.4	262	1.2	208	3.9	166	5.1	86	7.0
Hexachlorobenzene	at 1% TOC					< 0.2		< 0.2		< 0.2		< 0.2		< 0.2	
Total DDT	at 1% TOC	1.6	46		3.9	2.3	11.5	1.7	17.5	1.8	4.3	2.4	19.6	1.8	9.6

1 Polycyclic aromatic hydrocarbons have been summarised as “Total PAH” (all the PAH compounds analysed), and as “Total High Molecular Weight PAH”, which is the sum of the concentrations of chrysene, fluoranthene, pyrene, benzo[a]anthracene, benzo[a]pyrene, and dibenzo[a,h]anthracene. This is the total used for the ANZECC (2000) sediment quality guidelines and ARC ERC (ARC 2004). All the PAH compounds analysed are listed in Appendix 2.

2 For the purpose of calculating Total PAH, Total HMW PAH, and Total DDT, the concentration of any individual compound reported at “less than detection limit” has been replaced by a value one half of the detection limit.

3 DDT and related compounds have been summarised as “Total DDT”, which is the sum of the concentrations of 2,4'-DDE, 2,4'-DDD, 2,4'-DDT, 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT.

4 This TOC “normalisation” is used in the ANZECC sediment quality guidelines and ARC ERC for comparing sediments with different TOC content.

Table 4.2 *continued*: Summary of concentrations and variability (coefficient of variation [cv, %], n = 5) of total organic carbon (TOC) and selected organic contaminants in sediments of 17 sites sampled in Wellington Harbour in 2006. Sediment quality guidelines for comparison are ANZECC (2000) and Auckland Regional Council Environmental Response Criteria (ARC ERC; ARC 2004). Values in amber exceed the ANZECC ISQG-Low or ARC ERC amber threshold and values in red exceed the ANZECC ISQG-Low and ARC ERC red threshold.

Analyte	Fraction	ANZECC		ARC ERC		WH16		WH17	
	analysed	ISQG-Low	ISQG-High	amber	red	mean	c.v.	mean	c.v.
TOC (%)	< 500 µm					1.53	1.3	1.21	2.8
Organics (µg/kg):									
Fluorene	< 500 µm					5.32	3.1	3.58	3.1
Phenanthrene	< 500 µm					38.8	3.8	30.8	4.2
Benzo(a)anthracene	< 500 µm					37.8	24.1	30.2	2.8
Total PAH[1,2]	< 500 µm					534	9.5	442	3.0
Total HMW PAH[1,2]	< 500 µm					278	12.4	230	3.1
Hexachlorobenzene	< 500 µm					< 0.2		< 0.2	
Total DDT[2,3]	< 500 µm					2.3	3.1	1.8	2.5
Fluorene	at 1% TOC[4]	19	540			3	4.0	3	5.2
Phenanthrene	at 1% TOC	240	1,500			25	2.9	25	5.4
Benzo(a)anthracene	at 1% TOC	261	1,600			25	24.5	25	5.5
Total PAH	at 1% TOC	4,000	45,000			349	9.8	365	5.5
Total HMW PAH	at 1% TOC	1,700	9,600	660	1,700	181	12.7	190	5.6
Hexachlorobenzene	at 1% TOC					< 0.2		< 0.2	
Total DDT	at 1% TOC	1.6	46		3.9	1.5	3.6	1.5	4.9

1 Polycyclic aromatic hydrocarbons have been summarised as "Total PAH" (all the PAH compounds analysed), and as "Total High Molecular Weight PAH", which is the sum of the concentrations of chrysene, fluoranthene, pyrene, benzo[a]anthracene, benzo[a]pyrene, and dibenzo[a,h]anthracene. This is the total used for the ANZECC (2000) sediment quality guidelines and ARC ERC (ARC 2004). All the PAH compounds analysed are listed in Appendix 2.

2 For the purpose of calculating Total PAH, Total HMW PAH, and Total DDT, the concentration of any individual compound reported at "less than detection limit" has been replaced by a value one half of the detection limit.

3 DDT and related compounds have been summarised as "Total DDT", which is the sum of the concentrations of 2,4'-DDE, 2,4'-DDD, 2,4'-DDT, 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT.

4 This TOC "normalisation" is used in the ANZECC sediment quality guidelines and ARC ERC for comparing sediments with different TOC content.